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RESEARCH TRIANGLE INSTITUTE
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FINAL REPORT OU-107

Shelter Medical Support System Study

Office of Civil Defense Project 1341A

Part I by W. T. Herzog
Part II by W. L. Wells, M. D.
W. J. Cromartie, M. D.

31 August 1963

Prepared for
Office of Civil Defense
United States Department of Defense

under

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This report summarizes the research completed under the general terms of OCD Project No. 1341A, "Shelter Medical Support System Study." The Research Triangle Institute served as prime contractor on this study and was assisted, through a major sub-contract, by a team of medical specialists from the School of Medicine, University of North Carolina.

The general team contributing to the study at the Research Triangle Institute included: Messrs. K. E. Willis, J. G. Caldwell, G. R. Pappas, and Mrs. J. Suor. The team at the University of North Carolina included Drs. W. L. Wells, M. D. and W. J. Cromartie, M. D.

ABSTRACT

This study determined the conditions under which each community shelter or shelter complex could be made medically self-sufficient in a post-nuclear attack emergency period of two weeks. Various policies of allocating medical resources were analyzed with the conclusion that a policy of assignment of physicians and paramedical personnel to large shelters equipped with adequate supplies (herein defined by type) is superior to the concentration of resources in hospitals or treatment centers. The "best" physician assignment strategy requires their dispersal in high PF shelters. Although they serve fewer shelterees directly, when so dispersed, through reduction of physician casualties their services are preserved for the post-shelter period where, as other research has indicated, their contribution to survival is very high. Either strategy places a burden upon the other Civil Defense services. With the exception of communications, the demand placed upon such services (i.e., transportation, shelter management, public information) constitutes no serious problem.

The "fallout only" situation is analyzed in detail; the "best" physician assignment strategy derived in this analysis is shown to hold for direct weapons effects conditions as well. Preparation of prototype plans is recommended to further refine and demonstrate feasibility of these concepts of optimal medical resource allocation. Other areas of needed research include the development of more quantitative estimates of medical treatment capabilities, supply requirements, and care requirements.

Part I

ANALYSIS OF EXTERNAL MEDICAL SUPPORT SYSTEM STRATEGIES

Shelter Medical Support System Study

(OCD Project No. 1341A)

W. T. Herzog

Research Triangle Institute
Durham, North Carolina

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction

The objectives of this research were to determine:

1. To what extent can a single community fallout shelter be made medically self-sufficient by assignment of medical personnel to shelters and by stocking of medical supplies?
2. To what extent can a community fallout shelter complex be made medically self-sufficient by: (a) assigning medical personnel to shelters; (b) transferring patients between shelters and treatment centers; and (c) utilizing the communications system to provide medical consultation for persons in non-medical shelters?
3. What demands will an integrated medical support system place upon the following community civil defense services?
    a. Transportation
    b. Communications
    c. Warning and Public Information
    d. Shelter Management
4. What medical support system approaches the optimum?

Conclusions

1. An individual fallout shelter can be made self-sufficient medically to the point that about 94% of the sick and injured persons in the shelter (excluding weapons effects casualties) would survive. This level of

effectiveness requires assignment of at least one physician to the shelter with a medical kit consisting of adequate quantities of the items listed in Appendix C, Part II.

2. The extent to which an entire shelter complex can be made medically self-sufficient is a function of the expected proportion of the population in the "physician shelters," (as described in the above paragraph) and the proportion of medical cases which could be handled through external support measures (transfer to treatment facility) during the shelter period. It is estimated that about 96% of the medical cases (non-weapons effects casualties) could survive if a medical support system as defined in Section III, B, were provided. This would represent an addition of 2% survivors due to external support measures. Transfer of cases from shelters containing no medical personnel to medical shelters (physicians and supplies present) would increase their overall probability of survival by about 7 %, providing that such transfers were made after the external radiation had decayed to acceptable levels. In the situations considered, ranging from initial radiation intensities of 750r/hr to 10,000r/hr, such transfers would be feasible within one to five days after attack, assuming that the population were in adequate shelters before and after transfer. Remote diagnosis techniques would be especially valuable in determining which cases should be transferred. It is doubtful, however, that adequate communications systems would be available for this purpose.

3. The demand on the transportation system for transferring patients between shelters would be minimal, even with abnormally heavy caseloads. The demand on the communications system for remote diagnosis and treatment of

cases in non-medical shelters would also be small, but it is questionable whether even this requirement could be met during a postattack shelter period because of the competition with other civil defense communications requirements.

4. Although it is virtually impossible to devise an "optimal" medical support system, it is evident that a near-optimal system should include: 1) assignments of physicians to fallout shelters with the largest space capacities and highest PF's; and 2) should provide for stocking of special medical supplies therein. If the shelter characteristics of a community were such that all of the population could be located in such medical shelters, minimal provisions for transfer of cases during the shelter period would be required, and remote diagnosis and treatment capabilities would be unnecessary. To the extent that collocation of shelterees and physicians were infeasible, additional plans both for transfer of cases between shelters and remote diagnosis and treatment would be required.

Recommendations

1. A prototype medical support plan should be developed for one or more specific communities in order: 1) to test the feasibility of physician shelter assignments; 2) to refine the planning steps necessary for transfer of cases between shelters; and 3) to develop remote diagnosis screening techniques.
2. Further research should be conducted in order to estimate the maximum treatment capabilities of peacetime medical systems under several postattack conditions. This approach would provide one of the principal elements for estimating the upper limits, at least, of the quantities of drugs and supplies to be stocked for the shelter period.

3. The estimates of medical care requirements derived in Part II of this report constitute an original approach to this problem; the recognized shortcomings of these estimates are: (1) they are based upon a peacetime caseload spectrum appropriate principally to the "fallout only" situation; (2) they represent the medical judgement of a limited number of physicians. Accordingly, this research should be extended to insure coverage of typical direct weapons effects casualties and should incorporate the independent judgement of other physicians experienced in emergency medical care.

I. INTRODUCTION

A. Objectives of the Research

The Office of Civil Defense description of this project states:

> "The problems of providing adequate medical care during an emergency period during which the population is isolated in a system of shelters are not clearly understood.
>
> The contractor shall perform the necessary research to determine the following:
>
> 1. To what extent can each shelter or shelter complex be made self-sufficient medically through the stocking of medical supplies and equipment, the assignment of medical personnel, and the training of paramedical help?
> 2. Under what circumstances can patients be transferred to a hospital or medical treatment center after a nuclear attack?
> 3. What demands on communications, transportation, etc., would be made by an integrated medical support system?
>
> The purpose of this study is to anticipate the size and nature of the caseload in an area shelter system (not necessarily as the result of attack injuries), to explore the alternative means of providing medical support between shelters within the limitation of the postattack environmental conditions and to propose the most desirable medical support system on a cost-effectiveness basis."

This report responds to the above questions, and ends by citing several specific recommendations for operational implementation and for further research. The background data and detailed analysis which support the conclusions brought out in the text are included in the Appendices and in Part II.

The current program for defense of the civilian population in the event of an attack places strong emphasis on providing protection against the lethal effects of radioactive fallout. One of the first steps in this direction has been the National Fallout Shelter Survey which has consisted of identifying the existing structures (office buildings, schools, warehouses, etc.) that can give adequate protection against fallout. Buildings which meet the minimum standards of the Office of Civil Defense (OCD) are now being marked and stocked as public fallout shelters, and will be used as such in the event of attack. Many of the problems inherent in using such shelters and their effects on the population, however, are not clearly understood. In this research we have directed our effort toward the unique problem of providing medical support to populations confined to an area network of fallout shelters for up to a two week time period. Detailed analysis has been made of external medical support strategies for the "fallout-only" case, leading to the conclusion that assignment of physicians and paramedical personnel to large, high PF shelters is superior to a policy of assigning them to hospitals only. This conclusion is then tested in the situation where direct effects also occur (with and without fallout) and is found to be equally valid. Hence, detailed analysis of the spectrum of casualties and caseload due to direct weapons effects is neither required nor included in this report.

Because medical support planning is highly dependent on the shelter characteristics and medical resources of particular communities, no optimum strategy adaptable to all areas can be identified. Further, the extent to which medical resources should be conserved is largely a function of the probable need for such services in the post-shelter period; it is concluded in Reference 3 that

post-shelter medical requirements will be high. For example, there is some indication that the best strategy of assigning physicians to shelters, from the standpoint of survival of the most people during the shelter period, would carry with it some possibility of physician casualties. Before choosing such a strategy, however, there is need for some estimate of the potential cost in terms of fatalities during the post-shelter period.

B. Rationale

There are two aspects to providing medical support for a population confined to an area network of fallout shelters: (1) in-shelter medical care of shelter occupants; (2) external support of shelters without adequate in-shelter medical support capabilities. These aspects are closely related in that the medical self-sufficiency of the individual shelters defines the external measures which are necessary. If all shelters were completely self-sufficient medically, no external measures would be necessary. To the extent that the shelters within a complex lack medical self-sufficiency, external measures will be required. External support is constrained (mobility, communications, etc.) by the particular situation. The measure of effectiveness used in evaluating the medical self-sufficiency of individual shelters and the overall shelter complex is the expected increase in survival among medical cases.

C. Approach

The research on this project consisted of three major steps: (1) analysis of the civil defense systems aspects of medical support; (2) investigation of the medical caseload and treatment parameters; and (3) merging the information developed in steps (1) and (2) above, in order to evaluate the probable

effectiveness of several civil defense medical support policies. The Research Triangle Institute, the prime contractor, had primary responsibility for developing the outline of research, conducting the civil defense systems research and developing the summary report. Two members of the medical faculty of the University of North Carolina School of Medicine, serving as subcontractor to RTI, were responsible for furnishing the medical caseload and treatment parameters discussed in Part II. This study was directed by Dr. Warner L. Wells, M.D., Associate Professor of Surgery.

D. Scope of the Research

Because of the magnitude of the problem of planning for medical support of the population, it has been necessary to limit the scope of the research. In this study we have emphasized the problems of providing medical support for those elements of the population isolated in public fallout shelters under a range of fallout intensities. We have not investigated the special problems of providing medical support to direct weapons effect casualties or to persons affected by biological or chemical weapons agents, except to point out the limitations on treatment capabilities of the relatively small numbers of medical and paramedical personnel. Because of the lack of available data on non-public fallout shelters (home shelters and other private shelters), we have not included these shelters in our evaluation.

Further, we have concentrated our efforts on estimating the nature of the expected medical caseload, since this determines the types of medical support measures which are required and provides the basis for estimating the effectiveness of these measures in terms of survival. The extent of the expected casualty

and non-casualty medical caseload (gross numbers of patients) is more uncertain, and probably will remain so because of the general lack of knowledge about the nature of the attack and postattack environment. Nevertheless, maximum treatment limitations of medical resources have been estimated; these form a logical basis for estimating the maximum quantitative requirements for drugs, medical supplies, and the demand on the other civil defense services.

II. BACKGROUND INFORMATION ON MEDICAL CARE STRATEGIES

A. Medical Care Requirements

The following conclusions concerning the level of medical care required for adequate treatment by peacetime standards were reached in the course of a detailed study of local emergency room caseloads (analysis presented in detail in Part II).

Of all emergency room cases:

- 11% required intensive hospital care for adequate treatment of their particular illnesses or injuries as estimated from a detailed review of the numbers and types of conditions recorded (Category I);
- 46% required care by a physician for adequate treatment of their conditions (Category II);
- 43% required care by a skilled layman for adequate treatment of their conditions (Category III).

The above findings are of interest to emergency medical care planning of all types. Although typical illness profiles are available from other sources, comparable estimates of minimum requirements are not available from any other source known to the authors. As set forth in Part II, considerable effort and analysis was necessary in order to develop each of the above figures. Briefly, this consisted of the detailed review of over 15,000 emergency room cases as recorded in the 900+ disease and injury categories listed in the International Classification of Diseases, Adapted (Reference 1). By using these estimates we

are able to define the peacetime care requirements of emergency cases of the type observed in one area, and thus to estimate the need for various types of medical support services under peacetime conditions. These percentages were confirmed by additional analysis of: (1) hospital bed patients in one local hospital; and (2) the care requirements of general practice patients in the British National Health Service as reported in Reference 2.

In the hospital census data, (1) above, 9% of the cases were classified as requiring intensive hospital care, 53% required physician care, and 38% required layman care (see Part II). In the general practice cases reported by the British National Health Service, (2) above, about 8% would be classified (using the criteria reported in Part II) as requiring hospital care, 30% as requiring physician care; and 62% as requiring layman care.

In both comparisons the percentage of patients requiring hospital care was less than that observed among the emergency room caseload (11%). The percentage of cases requiring physician care was subject to a wider range of variation (53% and 30% in the examples shown above compared with 46% among the emergency room caseload).

B. Estimated Effectiveness of Degraded Medical Care

Because the above percentages represent the care requirements of the observed caseload using peacetime criteria, it is necessary to supplement these figures by estimating the care requirements of each category using criteria which are meaningful to the austere level of a postattack environment. We approached this latter viewpoint by estimating the number of deaths which could be expected in each category under successively degraded levels of medical care. Table I shows the results of this analysis in terms of the percentage of cases surviving at the

stated levels of care. These data provide the basis for our estimates of the "survival value" of the various medical support techniques and strategies.

TABLE I

Estimated Percentage of Cases Surviving at Various Levels of Medical Care

PEACETIME CARE CATEGORIES		Estimated Percentage of Cases Surviving			
		Without Care	With Nurse * Care	With Physician* Care	With Hospital** Care
I	"Hospital Cases"	58	62	68	85
II	"Physician Cases"	82	94	95	100
III	"Layman Cases"	100	100	100	100

SOURCE: These percentages were derived from Tables XIV-XVIII of Part II.

* The percentages estimated for physician and nurse care assume the availability of a limited supply of drugs and instruments as defined in Part II. The estimates for nurse care assume that the conditions have been diagnosed by a physician and treatment prescribed.

** The percentages for hospital care assume hospitals and personnel to be intact. This figure represents the expected peacetime survival.

It is important to note several facts which are fundamental to understanding the remainder of this report:

1. The survival ratio among the cases which we have classified as layman cases is not significantly changed regardless of the level of care provided. Virtually all of these cases could be expected to survive without care. This fact contributes heavily to the generally high rate of survival indicated in later discussions, and the apparently slight differences in the payoffs of the various strategies.

2. Nurse care is nearly as effective as physician care, especially with Category II cases. Because the probable roles and effectiveness of nurses and other paramedical personnel are being investigated in another research project by the U. S. Public Health Service, we have assumed that paramedical personnel will be assigned to support physicians, as they are in peacetime medical care.

By combining the percentages of cases in each care category and Table I and weighting the estimated percent survival in each category by the percent of cases expected in each category, we can summarize the overall survival values obtainable by various levels of care. Table II shows the results of such an analysis. This Table sets the stage for the estimated levels of medical self-sufficiency which can be reached within a single public fallout shelter as discussed in the next section.

TABLE II

Expected Percentage of Caseload Surviving at Various Levels of Medical Care Weighted by the Expected Percentage of Cases in Each Care Category

PEACETIME CARE CATEGORIES		Percent of Cases in Each Category	Survival: Without Care	Survival: With Nurse Care	Survival: With Physician Care	Survival: With Hospital Care
	All Cases	100	87	93	94	98
I	Hospital Cases	11	6	7	7	9
II	Physician Cases	46	38	43	44	46
III	Layman Cases	43	43	43	43	43

SOURCE: Derived from the care requirements of the emergency caseload (p. 11) and Table I (p. 13).

III. DISCUSSION AND CONCLUSIONS

A. Medical Self-Sufficiency of Individual Shelters

If a physician were assigned to an individual shelter and provided with adequate quantities of the drugs and supplies listed in Part II, about 94% of the persons becoming sick or injured due to normal causes would survive.*

Inasmuch as up to 98% would survive with hospital type care, an additional 4% survival over that expected from in-shelter care alone could be gained by transferring cases requiring hospital care to hospital shelters.

If no provision were made for medical support either internal or external, about 87% of the medical cases occurring in the shelter would survive.

We will therefore take the figure of 94% survival among the in-shelter medical cases as the measure of the maximum extent to which a shelter could be made medically self-sufficient by assignment of medical personnel, training of these personnel in shelter medical practice, and stocking of shelters.

The percentages given in this section have been taken directly from Table II above.

B. Medical Self-Sufficiency of the Fallout Shelter Complex

Having defined the extent to which an individual fallout shelter can be made medically self-sufficient in terms of survival, the next logical question is how self-sufficient can one make an entire complex of fallout shelters. It will be

---

* The survival of the radiation casualties which may occur will be discussed later.

seen that this is a function of the <u>strategies</u> followed for assigning physicians to individual shelters within the complex and the proportions of the caseload in each care category which can be expected to occur in these "physician shelters." The choice of a strategy of assigning physicians to shelters thus defines the remaining requirements for external medical support.

If all shelters could be provided the level of medical self-sufficiency characteristic of a hospital, no additional support measures would be effective or necessary. If physicians could be assigned to all of the shelters in a complex, about 11% of the cases occurring would have to be transferred to hospital shelters. If no physicians or paramedical personnel were assigned to shelters, about 57% of the cases would require transfer either to a physician shelter or a hospital.*

---

* For the purpose of illustrating the actual effect such strategies would have in a specific community it is necessary to consider the gross numbers of people involved in say a community of 100,000 population. It is difficult to estimate the gross numbers of cases to be expected. However, it is possible to estimate roughly how many cases the physicians in an average community could diagnose and treat in a two-week period. This approach is covered more fully in Appendices A, B, and C. There are 144 physicians (and osteopaths) per 100,000 population in the United States as a whole. If these physicians could, on the average, treat 12 persons per day for a two week period, a total of 24,192 persons could presumably be treated. Using the proportions established in Tables I and II we see that about 11,000 of these cases would require physician care and about 3,000 would require hospital care. Because approximately 87% of cases would survive with no medical care and 98% with excellent hospital care, the total number of survivors added could approach 3,000 persons. If all cases were given physician care as defined in Part II, the total number of survivors added would be about 1,600 persons, or 1.6% of the pre-attack population. Since we have assumed no constraints on medical personnel (mobility, supplies, casualties, etc.), the truth would probably be below the last figure. Note that a caseload of 24,192 persons over a two week period is about 24 times greater than the observed hospital emergency room caseload, and 5 times greater than the overall caseloads discussed in Appendix B. Therefore, we have here assumed an extreme caseload.

The following sections will consider the advantages and disadvantages of several alternative strategies of assigning physicians to shelters within a given shelter complex, and the resulting requirements for external support measures. The detailed background information for the conclusions stated here is presented in Appendices B and C.

1. <u>Assignment of Physicians to Shelters</u>*

a. <u>"Best" Physician Assignment Strategy</u>

The following analysis is based on the standardized community described in Appendix B.

If all medical personnel are assigned to hospital shelters, which constitute 4% of all shelter spaces, and no patient transfer is possible, then slightly over 87% of the cases would survive. This slight increase represents the maximum payoff of this assignment strategy, because even hospital care would be degraded by the fallout environment. Fifty-five percent of the cases would require resources external to their shelter in order to increase the overall survival rate.

If, at the other extreme, all medical personnel are assigned to the largest shelters in a community and medical supplies are available, 92% of the cases would survive, representing an increase of <u>5%</u> survival due to this strategy compared to the "no-care" strategy. Twenty-four percent of the cases would have to be transferred in order to further increase survival. However, this last strategy

* All of the numerical data in this report which relate to shelters or shelter spaces were derived from Phase I NFSS shelter characteristics described in Appendix B.

often assigns physicians to large shelters with lower radiation protection factors, thus risking an increase in physician casualties.

The "best strategy" for assigning medical personnel to shelters would seem to be one which locates a large proportion of the population in physician shelters while keeping the probability of medical personnel becoming casualties very small.* Generally, this strategy will require assigning medical personnel to the largest shelters with consideration being given simultaneously to radiation protection factors. In communities in which all of the population can be accommodated in a relatively few large shelters, the proportion of the population in shelters containing at least one physician would approach 100%. On the other hand, the proportion would be fairly small in those communities having predominantly small shelters. In our example, discussed in Appendices B and C, the strategy of assigning medical personnel to the largest shelters with protection factors greater than 100, indicated that physicians could be made available to 34% of the available shelter spaces of all size and PF categories.** We will use this percentage in our discussion, but caution the reader that this figure will vary considerably from community to community.

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* The critical importance of medical personnel in the post-shelter period is highlighted in Reference 3.

** The public shelter with a very large space capacity raises a question as to whether the assignment of a single physician would be adequate to treat the expected caseload. This is a function of the percentage of cases occurring in a given population and the total number of persons in the shelter. Generally, special stocking and assignment strategies would be essential for shelters with space capacities for more than 2,500 persons.

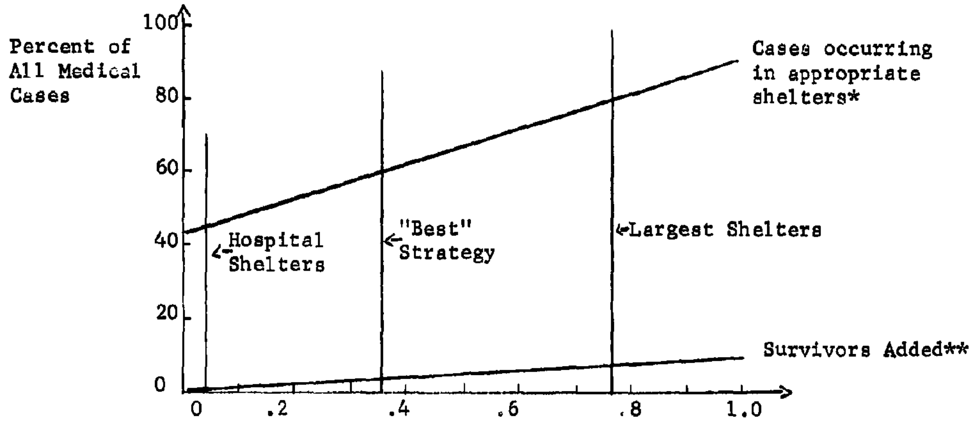
As shown in Figure 1, about 90% of the cases would survive if the "best" strategy were carried out with no external support measures, although thirty-eight percent of the cases would require external support in order to increase the above survival rate.

The upper line indicates the proportion of cases which can be expected to occur in shelters that have the capability of providing appropriate medical care, i.e., physician care for physician cases, etc. As shown on the left of the chart, 43% of the cases (the layman cases) would receive adequate care if no physicians were assigned to shelters, and, on the right, about 11% of the cases (the hospital cases) would not receive appropriate care regardless of the shelter assignment strategy. The lower line indicates the <u>increase</u> in the <u>overall survival</u> among cases as a function of the percentage of the population confined within physician shelters.

Generally, the payoff of such physician shelter assignment strategies could be significantly increased and the external support requirements reduced, if hospital cases and other chronically ill persons were assigned to the hospital shelters on warning of impending fallout.

FIGURE 1

Medical Cases Which Occur in Shelters with Appropriate Treatment Capabilities and Survivors Added as a Function of Population in Physician Shelters



Proportion of the Population in Shelters with One or More Physicians.

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* Forty-three percent (shown at the left side) of all cases are layman cases. The maximum percent of cases occurring in appropriate shelters is computed by adding the percent of layman cases occurring in all shelters, the percent of physician cases occuring in physician shelters, and the percent of hospital cases occurring in hospital shelters.

** The percentage of survivors added is the increase over the base survival rate without care (87%). The maximum percent of cases surviving is computed by adding the percent of layman cases surviving, the percent of physician cases surviving with physician care, and the percent of hospital cases in hospital shelters who survive with hospital care.
(.43) + (.46 X 94) + .11 (.04 X .98 + .96 X .68) = .94

b. Methodology

The percentage of cases surviving in the several possible shelter assignment strategies can be estimated in the following way. As roughly 4% of all shelter spaces are located in hospital shelters (as reported in Phase I NFSS special summaries) it can be estimated that about 4% of the cases in the community would occur in hospital shelters. The proportionality would not hold exactly because the more severe cases present at attack time are already in the hospitals.

We then compute the expected survival by adding: 1) the proportion of cases in hospital shelters multiplied by the survival rate with hospital care; 2) the proportion of cases expected in physician shelters multiplied by the survival rate with physician care; and 3) the proportion of cases occurring in the shelters without physicians multiplied by the survival rate with no care. For example, the expected survival among cases in our "best" strategy is (.04 X .98) + (.30 X .94) + (.66 X .87) = .90.

By assigning one physician to each of the largest shelters, regardless of PF, roughly 70% of the medical cases would be estimated to occur in physician shelters which would yield a survival rate of .92 = (.04 X .98) + (.66 X .94) + (.30 X .87). In this strategy the majority of physicians would have to be assigned to shelters with PF's of less than 100.

2. <u>Effect of Transfer on Medical Self-Sufficiency of the Fallout Shelter Complex</u>

By providing hospital care to hospital cases and physician care to physician cases about 96% of the persons becoming sick or injured during the shelter period would survive. We will therefore take 96% survival among the normally sick and injured persons as the overall upper limit of the extent to which a fallout shelter <u>complex</u> can be made medically self-sufficient by assigning medical personnel to shelters and transferring patients to appropriate treatment locations during the shelter period. The vehicle hour requirements of transferring patients are discussed subsequently.

3. <u>Effect of Communications</u>

Communications are an essential element in coordinating and controlling the medical support system during the shelter period. They may also be of use in providing direct support for shelters without any skilled medical personnel. Telephone consultation with shelter occupants could be valuable in diagnosing and prescribing treatment for sick or injured shelter occupants. With a nurse or other skilled paramedical person in the shelter, the effectiveness of remote diagnosis and treatment might reach an expected survival rate of as much as 93% (i.e., the estimated survival value of nurse care after a disease has been diagnosed and treatment prescribed by a physician). The use of such a technique for screening of patients in order to decide which require transfer to physician or hospital shelters can be expected to add greatly to the overall efficiency of the medical support system. Communications requirements are estimated quantitatively in Section IV.

IV. DEMANDS OF THE MEDICAL SUPPORT SYSTEM ON OTHER CIVIL DEFENSE SERVICES

The demand estimates for transportation have been developed from analysis of the particular characteristics of the standardized urban area described in Appendix B. The particular values for any specific urban area will depend on the medical resources, shelter characteristics, and population characteristics of that area.

A. Transportation System

Transfer of patients to more appropriate medical shelters can be accomplished by two means -- walking or by vehicle. The patients who walk or are carried would not place any demand on the transportation system, but the dose received in such movement would be greater than that received in vehicle movement because of the duration of external exposure required. If physicians were distributed among the largest shelters with the highest PF's, the average distance between non-physician shelters and physician shelters would generally permit walking transfers of this type within one to two days after attack, at added doses of less than 10 - 20r. This would hold for environments with H+1 radiation intensities of less than 10,000 roentgens per hour. Transfer of patients from shelters to hospital shelters would on the average involve greater distances which would generally require the use of vehicles.

The total vehicle-hour cost of transferring hospital cases to hospital shelters in our standardized urban area example would be about .1 hour per case, assuming an average speed of 15 mph. For an overall caseload of 10,000 for

example, 1,100 cases would require hospital care. Thus, except for the few cases which would occur in hospital shelters, about 100 vehicle transit hours would be required for such movement. If physician and hospital cases were transferred to appropriate medical shelters by vehicle, and physicians were located in the largest and highest PF shelters, about 710 vehicle transit hours would be required over a two week period for an overall caseload of 10,000 patients, or about 50 vehicle hours per day. Although this is admittedly a crude estimate it does indicate that the overall demand for vehicles would not be excessively high even when generous allowance is made for turn around time, lost time, etc. These figures exclude direct weapons effects casualties, and radiation casualties which will be discussed later.*

B. Communications System

Communications will be essential to all elements of the medical support system which involve coordination and control during the in-shelter period. Lack of communications would have the least effect on the care of patients within the physician and hospital shelters, but even in these, requests for replenishment of supplies or calls for other assistance will be necessary.

In addition to the need for communications in order to maintain coordination and control of the elements of the medical support system, communications could be used to provide remote medical consultation for shelters which do not contain medical personnel. As a minimum, the need for this type of communication is determined by the proportion of all cases isolated from medical personnel during the shelter period. If physicians were available to 34% of the cases (the "best"

---

* The analysis indicates that the vehicle hour requirements would also be a function of the overall service rate of the available medical resources. In other words, the total vehicle hours required would be limited by the number of patients which could be treated.

strategy in our standardized urban area analysis), 66% of the cases would be expected to request remote medical consultation, or 6,600 out of 10,000 cases. If the average time required were 15 minutes, for example, about 1,650 communication hours would be required, or an average of 118 hours per day. In one large shelter of 1,000 persons with no medical personnel present, about 2 hours per day would be required for medical communication without direct weapons effects. In reality, because the shelters in question are without physicians, the requests for medical consultation would by no means be confined to the casualties to whom such consultation is essential. A factor of two would seem to be a very conservative under-estimate of this increase in medical or allied communications. If one recognizes the likely breakdown in communications discipline and the demand of other CD services (radiological monitoring, shelter management, etc.), it is obvious that the communications system generally will be seriously over-loaded. This would especially be true in shelters having only a few telephones or a single radio transmitter/receiver.

For remote diagnosis and treatment centers, normally located in hospitals, the communications requirements would be much more nearly matched to expected facilities (118 daily hours cited above = 5 channels -- radio or telephone -- which could be handled by 10 physicians working 12 hour shifts, or 7% of the available physician man-hours). Increasing this by a factor of 2, still represents only a modest fraction of the total available physician hours and is in line with typical hospital telephone communication capability.

In summary, communications requirements related to medical support will probably not be met with facilities normally present in community fallout shelters without extensive preplanning and probably augmentation of shelter communication facilities.

The reliability of telephone systems during unattended operation in fallout is probably good, but detailed analysis is beyond the scope of this study.

If direct weapons effects are experienced, the communications inadequacies are obviously even more marked.

C. Warning and Public Information

In order to implement a CD plan involving physician shelter assignment, a considerable amount of preattack planning, training, and instruction would be necessary. If one adopts the policy of assigning sick and injured persons to hospital and physician shelters at warning, public information broadcasts would be needed to issue instructions as to the locations of these facilities. The cost of building such instructions into the plans for emergency public information broadcasts would be minimal.

D. Shelter Management

Cases occurring in shelters without medical personnel present would represent a heavy load on the time of the shelter manager and radiological defense officer. The shelter manager should know the locations of physician and hospital shelters and should have instructions available within the shelter for judging the severity of cases. Additional support in this regard could be provided by a remote diagnosis system. The radiological defense officer should be capable of estimating the time at which transfer of cases becomes feasible.

V. INFLUENCE OF WEAPONS EFFECTS CASUALTIES ON CHOICE OF STRATEGIES

A. Radiation Casualties

At present, there is no established medical therapy for general use in the mass treatment of radiation casualties. The measures which are recommended do not require the services of a physician or a skilled paramedical person, as is illustrated in the following quote taken from the NATO Handbook on Emergency War Surgery (Reference 4):

> "To date, no specific therapy which will reverse pathologic changes in the tissues is available for casualties who have received lethal or sublethal dosages of ionizing radiation. This does not, of course, mean that all therapy is futile. Both mortality and morbidity will be reduced by such measures as rest; light sedation; a bland, nonresidue diet; maintenance of the fluid balance; and cleanliness and local care of the skin.
>
> In seriously injured casualties who are suffering from nausea, vomiting, and diarrhea, the maintenance of the water, electrolyte, and acid-base equilibrium is extremely important. The use of whole blood and the parenteral administration of fluids and nutrients will reduce both the morbidity and the mortality. While whole blood transfusions play an important part in the therapy of ionizing radiation injuries, the routine use of blood is not indicated, if only because this important substance must be conserved and used only on clear indications.
>
> The use of broad-spectrum antibiotics is an important part of treatment, but it is rather difficult to outline a definite schedule of administration. The bacteria normally present in the body have a strong tendency to develop resistance to antibiotics within a short time. Therefore, even though antibiotics are of established value in pancytopenic states, it is unwise to use them prophylactically in ionizing radiation injuries, both because of the tendency of bacteria to develop resistance to them and because they will probably be in short supply because of the large number of casualties. Other contraindications to the routine use of antibiotics for prophylaxis include the variable individual response and the lack of precise correlation between measured dose and effect. For these reasons, antibiotic therapy should be instituted only on the basis of individual requirements."

Therefore, we are forced to accept the conclusion that the treatment of radiation casualties by elements of the medical support system would have relatively little payoff in terms of survivors added, above that which would be obtained by providing lay care. This conclusion was borne out in a search of the available literature including References 4 through 10.

It has been necessary to consider the influence of radiation casualties on the remainder of the population. There is some evidence in the above cited references which indicates that sublethal doses of gamma radiation would increase the general susceptibility of the population to disease, and increase the severity of the conditions of the normally sick and injured population. There is, however, no way to quantify the extent or nature of these effects.

If all shelters had protection factors of 100 or more and the reference dose rate was less than 5,000 roentgens per hour, very few radiation casualties could be expected, except among persons who were temporarily exposed to the external environment. In such a situation, medical treatment of the few existing casualties could be feasible and would have some limited effectiveness, because there are established medical techniques for dealing with small numbers of radiation casualties. Each casualty could be given individual attention and treated according to the requirements of his particular condition. With reference H+1 dose rates greater than 5,000 roentgens per hour, radiation sickness would begin to occur even among shelterees in shelters of about 100 PF . Under these circumstances provision of medical support would become extremely complicated. The symptoms of radiation sickness are such that it could be confused with many other illnesses even by physicians. The incidence of vomiting in shelters can be expected to spread throughout each shelter and to affect many persons who are not themselves sick due to radiation. The theoretical 5-10% vomiting cited for

given doses of radiation is hard to accept for a crowded fallout shelter with poor ventilation. In shelters with a high incidence of vomiting and diarrhea, widespread occurrence of enteric infection, especially bacillary dysentery (Shigellosis) can be expected, since a reservoir of infection is almost always present and susceptibility is high. This would have fatal consequences for the infants within the shelter unless antibiotics are available. Diagnosis would, however, be difficult since many enteric diseases could be confused with radiation sickness in the absence of laboratory diagnostic facilities.

In most communities the population will be dispersed among shelters with varied radiation protection factors. In order to provide shelter for the total population, as we have in the example given in Appendix B, shelters with protection factors as low as 20 would have to be used. In this situation, radiation casualties and even deaths could be expected in the lower PF shelters before the occupants of the high PF shelters were affected. If physicians were assigned to shelters with the highest PF's, they would be separated from the casualties, thus unable to treat them. If physicians were assigned to the low PF shelters, they would become casualties themselves in the same proportions as the rest of the shelter occupants. In either situation the treatment of large numbers of radiation casualties would be ruled out.

B. Direct Weapons Effects Casualties

This research has been oriented towards the "fallout only" situation. One principal conclusion has been that a strategy of assigning physicians and paramedical personnel to shelters is superior to assigning them to a few central locations such as hospitals. It is pertinent here to consider whether such a physician assignment strategy is appropriate when direct weapons effects (including fire) occur as well.

1. Direct Effects - With Fallout

Two sub-cases are of interest: direct effects occurring before or after the population has entered shelter. If the population is caught out of shelter, the situation generally will be very severe: many casualties from blast, thermal effects, and radiation (prompt and fallout), as well as general inability to function effectively or execute any physician assignment plan or be very effective by any means we have conceived.

If direct weapons effects occur after the population has entered shelter, and physicians and paramedical personnel have entered the large, high PF shelters, then casualties will be close to physicians,but physicians themselves will experience casualty rates similar to the population generally. Although their effectiveness in such a situation would be in serious doubt, some survivors could without question be added by their presence. Because in this attack environment movement is precluded, physicians employing the other strategy of concentrating in hospitals would be useful only to those victims also injured in the hospitals by the direct effects. Further, concentrating the physicians in the few hospital shelters is a high risk alternative, for the hospitals might be in the most severely damaged part of the community, thus wiping out most or all medical resources. Accordingly, in this case, the recommended strategy of dispersing physicians and paramedical personnel is no worse, and probably considerably better, than concentrating them in the hospitals.

2. Direct Effects - No Fallout

If direct effects are received before the population enters shelters, similar remarks to those made above apply. If direct weapons effects occur after shelter entry, then physicians dispersed in shelters are in a position to treat weapons casualties insofar as the physicians and other medical resources survive. Were physicians concentrated in hospitals, then the following disadvantages accrue:

a. The general lack of communications and debris-limited mobility would seriously handicap both the movement of physicians to the casualties, or the (probably preferable) movement of casualties to the hospitals for treatment.

b. The concentration strategy again exposes physicians to a higher risk of a major proportion of them becoming casualties to direct effects.

Accordingly, a similar conclusion may be drawn in this case: The dispersal strategy recommended for physicians and paramedical personnel is also at least as good as a strategy of concentrating them in hospitals if this close air-burst situation occurs.

Appendix A

ANALYSIS OF MEDICAL CASELOAD CHARACTERISTICS

Extent and Nature of Medical Caseloads

Any attempt at analysis of medical treatment requirements for a given population requires, as a basis, specific data on the types of diseases and injuries which make up given medical caseloads. Unfortunately, there is a general paucity of such information. In planning for emergency medical care during the shelter period we are interested primarily in those medical cases which relate to the effective survival of the patients, and which require immediate attention. The limited data available, however, generally include a large number of cases which are not of an emergency nature; thus, these data are of little value to the problem at hand. In peacetime many health problems are treated which relate more to the comfort of the patient than to his survival. Respiratory conditions, for example, often constitute the largest single category in observed caseloads. Many of these conditions do not require care for survival. In addition, various other conditions, the care of which can be temporarily deferred, are not pertinent here.

In order to clarify the nature of the probable medical caseload, Drs. W. L. Wells and W. J. Cromartie of the School of Medicine, University of North Carolina, carried out a detailed study of approximately 16,000 emergency room cases in four local hospitals. This study was conducted under a subcontract with RTI;

the results of which are presented in Part II. Additional caseload information of a more general nature was obtained about the Health Insurance Plan of Greater New York (Reference 11) and the British National Health Service (Reference 2). Data on the overall public health problem during the two week shelter period (Reference 3) were also incorporated.*

Table A-I compares data gathered from these sources. As apparent in the table, there is a marked difference in caseload magnitude (per adjusted 100,000 population) for the three different groups sampled: hospital emergency room patients (Columns 1 and 2), general practitioner patients (Columns 5 through 8),** and National Health Survey cases (Columns 3 and 4). For example, there are approximately 200,000 acute conditions but only 26,000 emergency cases annually per 100,000 population.

Using the data presented in Table A-I, we can estimate the average two week caseload (adjusted to 100,000) for the three groups. Total caseload could range from 1,000 to 7,700. We could expect about 7,700 acute cases, some 1,900 general practice cases, and about 1,000 emergency cases.

Comparison of the nature of the sampled caseloads reveals several important differences. Injuries, for example, constitute the greatest burden among <u>emergency room cases</u>, followed by general symptoms and senility, respiratory conditions, and digestive conditions. In the other caseloads, respiratory and central nervous system conditions, principally eye and ear problems, are the most common. Thus, respiratory conditions would be widespread in an ensheltered population and would result in numerous requests for physician services. Whether or not such services

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* Reference 3 reports a research project conducted jointly by the School of Public Health, University of North Carolina, and RTI.

** Note that the H.I.P. sample (Columns 7 and 8), and Columns 5 and 6 both represent general practice cases.

TABLE A-I

Comparison of Several Observed Medical Caseloads*

CATEGORY OF DISEASE OR INJURY	EMERGENCY ROOM CASELOAD		ACUTE CONDITIONS		VISITS TO GENERAL PRACTITIONERS IN ENGLAND		SERVICES GIVEN TO H.I.P. (N.Y.) MEMBERS	
	Number**	Percent Each Category	Number**	Percent Each Category	Number**	Percent Each Category	Number**	Percent Each Category
TOTAL	26,173	100.0	201,900	100.0	125,720	100.0	149,640	
Infective Parasitic	347	1.3	27,600	13.6	5,500	4.4	3,800	2.5
Neoplasms	159	0.6	***	***	1,070	0.8	2,910	1.9
Allergic & Metabolic	784	3.0	***	***	5,080	4.0	9,590	6.4
Diseases of Blood	51	.2	***	***	1,430	1.1	1,290	.9
Mental Disorders	499	1.9	***	***	5,000	4.0	4,500	3.0
Central Nervous System	772	2.9	***	***	11,980	9.5	16,120	10.8
Circulatory System	559	2.1	***	***	6,840	5.4	8,190	5.5
Respiratory System	2,946	11.2	110,300	54.6	26,420	21.0	42,180	28.2
Digestive System	1,496	5.7	12,700	6.3	10,700	8.5	10,790	7.2
Genito-Urinary System	999	3.8	***	***	5,290	4.2	8,010	5.3
Complications of Pregnancy	699	2.7	***	***	1,690	1.3	1,820	1.2
Diseases of Skin	802	3.1	***	***	10,560	8.4	12,250	8.2
Diseases of Bone	349	1.3	***	***	8,680	6.9	11,230	7.5
Congenital & Early Infancy	51	0.02	***	***	460	0.04	450	.003
Symptoms Senility & Others	4,841	18.5	***	***	9,480	7.5	6,540	4.4
Injuries	10,819	41.3	27,900	13.8	10,200	8.1	9,970	6.7
Other	***	***	23,400	11.6	5,340	4.2	***	***

* These data are presented for illustrative purposes. Since the coding criteria used in the references differ slightly, the data are not precisely comparable.

** Annual rate per 100,000 population.

*** Category not included in Reference.

SOURCE: Columns 1 and 2 (see Part II);
Columns 3 and 4 (References 3 and 12);
Columns 5 and 6 (Reference 2);
Columns 7 and 8 (Reference 11).

were given in an emergency would depend on the policies of the medical support system. Although accidental injuries contribute heavily to the emergency room caseload in peacetime, it is uncertain whether this would continue in a shelter situation.

Treatment Load on the Medical Services

Because of the problems of extreme variation in estimating the medical caseload to be expected over a two-week period, we have examined several estimates of the overall treatment capabilities of the medical services. If the gross number of cases is such that the remaining medical support system is completely overwhelmed, the number of patients treated will be a function of the servicing rate of the medical personnel. Therefore, so far as the medical support system is concerned, the requirements for drugs and the demands upon the transportation and communications systems will be limited to the maximum number of cases that can be treated.

There are numerous ways of approaching estimates of the overall treatment capabilities of the medical resources in emergency situations by extrapolating from peacetime data. For example, estimates of the treatment times required for different kinds of medical conditions are presented in Table A-II. This information indicates that a total of 1.87 physician hours is required in order to treat an "average" case. If 144 physicians (the average number of physicians per 100,000 persons) worked 12 hours per day for 14 days, approximately 24,000 physician man-hours would be available. If each case required 1.87 physician hours (see Table A-II, Column 2), a total of 12,800 cases could be treated -- assuming that: 1) no time was lost between treatment of cases; 2) no physicians

became cases themselves; and 3) there were no bottlenecks in the supply of drugs or materials. Because the physician-population ratio is higher in many urban areas (i.e. greater than 144 physicians to 100,000 population), the overall treatment limit in urban areas is probably somewhat higher (see Reference 13).

TABLE A-II

Suggested Treatment Parameters for Peacetime Care of Specified Diagnosis Categories

Diagnosis Categories	Expected Cases Per 100,000	Physicians Hours Per Case (average)	Nursing Days Per Case (average)	Attendant Days Per Case (average)	Hospital Days Per Case (average)
TOTAL	103,661	1.87	0.53	0.99	3.62
Infective & Parasitic	11,550	2.26	1.54	3.80	3.54
Neoplasms	***	***	***	***	***
Allergies & Metabolic	2,100	3.60	1.70	1.93	4.36
Diseases of Blood	***	***	***	***	***
Mental Disorders	***	***	***	***	***
Central Nervous System	5,099	2.80	1.48	3.71	40.6
Circulatory	1,850	5.00	1.11	***	1.64
Respiratory	47,400	1.34	0.22	.046	1.24
Digestive	11,700	1.93	0.16	0.14	1.96
Genito-Urinary	12,916	6.85	1.52	***	5.25
Complications Pregnancy	2,356	11.60	2.16	2.28	8.64
Skin	1,990	1.00	0.15	***	0.23
Bones	1,300	2.46	0.25	***	2.89
Congenital & Early Infancy	***	***	***	***	***
Symptoms & Senility	***	***	***	***	***
Injuries	5,400	1.02	.40	***	.91

SOURCE: Derived from Reference 14.

*** Value not included in reference.

Appendix B

GENERAL CHARACTERISTICS OF A STANDARDIZED URBAN AREA

Because of the wide geographic variation in population, fallout shelter, and medical resource characteristics within the United States, we decided early in the research to focus our analysis on a hypothetical urban area which could be considered characteristic of the United States as a whole. This "Standardized Urban Area," described at length in Reference 15, consists of a city of 100,000 with shelter and population characteristics defined in such a way as to be typical of the United States. These characteristics were essential for the research reported herein and for the research work on OCD Project No. 2411A, Emergency Health Problems Study, conducted jointly by RTI and the Department of Public Health Administration, University of North Carolina.

In this Appendix we will briefly review: (1) general shelter characteristics; (2) several strategies of assigning physicians to shelters; (3) estimates of the average distances between non-medical and medical shelters; and (4) the effects of three fallout situations on the population.

Shelter Characteristics

The shelter characteristics shown in Tables B-I and B-II were derived from National Fallout Shelter Survey, Phase I computer printout sheets, dated 3 July 1962. Because this information was necessary during the early phases of the research it is now somewhat outdated in that proportionately more shelter spaces are currently available to the population than indicated below. For our analysis

we have assumed full utilization of all shelters identified in all PF and Space Capacity categories. In actuality, the shelters being marked and stocked as fallout shelters represent only a portion of these.

Table B-I gives the distribution of shelters by several PF and Space Capacity categories.* This information is the basis for estimating the proportion of the population which can be located in physician shelters under the various shelter assignment strategies. It also provides the basis for estimating the numbers of radiation casualties under different attack conditions.

TABLE B-I

Number of Shelters by Radiation

Protection Factor Ranges and Capacity

Capacity	Total	Protection Factor Ranges			
		20 - 39	40 - 69	70 - 99	100 and above
All shelters	497	220	110	40	127
50 - 99	75	38	14	5	18@
100 - 299	157	80	37	13	27@
300 or more	105	45	25	11	24@

@ Shelters marked and stocked under the NFSS program (contain 27,300 spaces).

Table B-II gives the distribution of shelter spaces in the four PF categories. In Appendix C we have equated population with shelter spaces assuming a uniform distribution of population in shelters. That is, the population has been assumed to be distributed among these four PF categories in the same proportion as shelter spaces.

A shelter as defined in this table may consist of one unit within a building or separate buildings; therefore, some of the shelters listed can be assumed to be on different floors of the same building. This indicates that the transfer problems in reality would be somewhat less than those illustrated in the text.

TABLE B-II

Number of Shelter Spaces by Radiation

Protection Factor Ranges

	Protection Factor Ranges				
	Total	20 - 39	40 - 69	70 - 99	100 and above
Total Spaces	111,700	46,300	25,300	10,800	29,300

Physician Shelter Assignment Strategies

Of all the variables that must be considered in analyzing the various medical support countermeasures, the assignment of physicians to shelters is the only one that can be effectively controlled on a practical basis. In the body of this report we considered several strategies of physician assignment in general terms. Here we will introduce the methodology used to derive the expected proportions of the population which would be in physician type shelters under four shelter assignment strategies. The numerical values of these strategies for the standardized urban area are discussed in Appendix C.

The strategies which we have evaluated more specifically than those presented in the body are listed below:

STRATEGY 1. Place $b < d$ physicians in hospitals and assign the remaining $d - b$ physicians one each to shelters of size > 50 having the highest protection factors;

STRATEGY 2. Place $b < d$ physicians in hospitals and allow the remaining $d - b$ physicians to enter other shelters at random with the general shelter population;

STRATEGY 3. Place all d physicians in hospitals;

STRATEGY 4. Place $b < d$ physicians in hospitals and assign the remaining $d - b$ physicians to the largest remaining shelters;

where b = the number of physicians in hospital shelters, and d = the total number of physicians in the community.

Additional notation is required in the following derivations:

T = total number of shelter spaces

n_t = number of non-hospital shelters containing (t) shelter spaces

S_h = proportion of shelter spaces which are in hospitals

S_{pi} = proportion of shelter spaces in shelters containing at least one physician when physician assignment strategy (i) is used.

Then we have:

1. $S_{pi} = S_h +$ (the number of spaces in the $d - b$ remaining shelters of size > 50 having the highest protection factors) / T

2. $E(S_{p2}) = S_h + \frac{\sum_t Pr(X_t \geq 1)\ t\ n_t}{T}$

where $E(S_{p2})$ = expected value of S_{p2} and $Pr\ (X_t \geq 1)$ = probability that at least one physician enters a given shelter of size t.

We have $Pr(X_t \geq 1) = Pr(Y_t \geq 1)$ where Y_t is a random variable having a Poisson distribution* with parameter $p = \frac{t(d-b)}{T(1-S_h)}$

* If Y is a random variable having a Poisson distribution with parameter P, then the probability that Y is equal to K is

$$Pr(Y=k) = \frac{P^K e^{-p}}{K!} \quad (K = 0, 1, 2, \ldots).$$

3. $S_{p3} = S_h$

4. $S_{p4} = S_h$ + (the number of spaces in the (d-b) largest shelters)/T.

Average Distances Between Non-Medical and Medical Shelters

The distance between shelters without appropriate medical capabilities and medical shelters is an important parameter in estimating the vehicle hours required to transfer patients and in determining the feasibility of such transfers under the several fallout environments. In our analysis we have considered the average distance between non-medical shelters and hospital shelters ($\bar{D}_h$); and, the average distance between non-medical shelters and physician shelters ($\bar{D}_{pi}$).

In order to obtain estimates for $\bar{D}_h$, two models of a city having a radius of 5 miles and its shelter system are first considered, using the shelter characteristics presented in the first section of this Appendix. The first model consists of a city having a circular normal density of shelter population and a hospital at its center. The street system of the city is rectangular and it is assumed that a person traveling from a shelter to the hospital must follow the streets. The expected distance $\bar{D}_h$ that a person chosen at random has to travel to reach the hospital is then given by

$$\sqrt{\frac{4}{2\pi\sigma^2}} \int_0^\infty x \exp\left[\frac{-x^2}{2\sigma^2}\right] dx = \sqrt{\frac{8\sigma}{\pi}} = 1.6\sigma \qquad \text{(B-1)}$$

where σ = the standard deviation of the normal distribution. The second model city also has a rectangular street system and a hospital at its center, but the shelter population is distributed uniformly over a circular area. The expected distance $\bar{D}_h$ in this situation is given by

$$\frac{2}{\pi R^2}\int_0^{2\pi}\int_0^R r^2 \,|\cos t|\, dr\, dt = \frac{8R}{3\pi} = .85R \qquad \text{(B-2)}$$

where R = radius of the circular area.

In a city of size 100,000, it is more realistic to assume that rather than one hospital at its center, the city has three hospitals at various locations in the city. However, the analysis becomes much more complicated and we limit ourselves to estimating that $\bar{D}_h$ in this situation is somewhat less than in the one hospital situation. We expect that the $\bar{D}_h$ would be reduced to approximately 1.2σ in the circular normal distribution model and approximately .6R in the circular uniform distribution model. In a city of 100,000 population, representative values for σ and R are $\sigma = 1.25$ and $R = 2.5$. Thus for such a city $\bar{D}_h = 1.5$ is a reasonable estimate.*

The average distance between non-medical shelters and physician shelters ($\bar{D}_{pi}$) depends on the specific shelter assignment strategy (i) being considered. If strategy three is used, then clearly $\bar{D}_p = \bar{D}_h$; if physicians could be available in all shelters, then $\bar{D}_p = 0$. It is reasonable to assume that $\bar{D}_p$ decreases in a "faster than linear" fashion from $\bar{D}_h$ to 0 as the proportion of the population in physician shelters (S_p) increases from S_h to 1. (We use the proportion of shelter spaces in hospital shelters (S_h) as the minimum value for S_p). A reasonable expression for $\bar{D}_{pi}$ is thus:

$$\bar{D}_{pi} \approx \bar{D}_h \left(\frac{1 - S_{pi}}{1 - S_h}\right)^2 \qquad \text{(B-3)}$$

The expressions derived above are, of course, applicable only to the extent that the model used describes the real situation, and the numerical

* Further discussion of the distributions of populations and shelter spaces in cities is included in References 16 and 17.

results obtained using these expressions are no more reliable than are the numerical estimates of the parameters on which these expressions depend. While the model appears to be an adequate representation of the qualitative aspects of a real situation, there is a range of possible values for the parameters associated with the model.

Attack Characteristics

Three levels of radioactive fallout were considered as depicted in the schematic view of Situations A, B and C shown in Figure B-1. This figure also indicates the basic assumptions which were used in estimating the total dose received over a four day period. Reference (15) contains a more detailed description of the computations and the build up of dose over a 14 day period. The H+1 reference dose rates (theoretical dose rate at 1 hour after the burst) assumed for each situation were: Situation A - 750 r/hr; Situation B - 2500 r/hr; Situation C - 10,000 r/hr.

Table B-III summarizes the effects of the three fallout situations on the shelter occupants. If physicians were assigned to shelters in each category in the same proportion as the population, similar casualty estimates would be obtained. This would correspond to random assignment as in Strategy 2. In Situation A, no casualties occur. In Situation B, 40% of the population would be expected to be sick after four days exposure. However, none would be fatally injured; thus, the provision of care to these casualties would not add a significant proportion of survivors. In Situation C, all of the population would be sick due to radiation effects and 66,440 persons would be fatally injured. Persons in shelters with PF's between 20-39 would receive about 900r over the four day period indicating that medical care would have little or no value in terms of

survival. In the other PF categories, the dose received would be less than 490 roentgens. Of these about 43% would be fatally injured. Because there is no established medical therapy for treatment of such casualties it is doubtful that medical care per se could greatly influence the survival rate much more than intelligent lay care.

Figure B-2 and B-3 present the curves used to estimate the casualties described in Table B-III. The maximum estimate curves were used, thus the extent of the casualty problem may be somewhat overstated in the analysis. These curves were derived in order to summarize the range of uncertainty about the effects of radiation found in the cited references. Estimates of the LD 50 for humans, for instance, can be found which range from 300r to 700r. Had the minimum estimates of fatality been used in Table B-III, we would expect about 44,700 casualties instead of the 66,440 indicated.

SCHEMATIC SIDE VIEW OF SITUATIONS 1-3

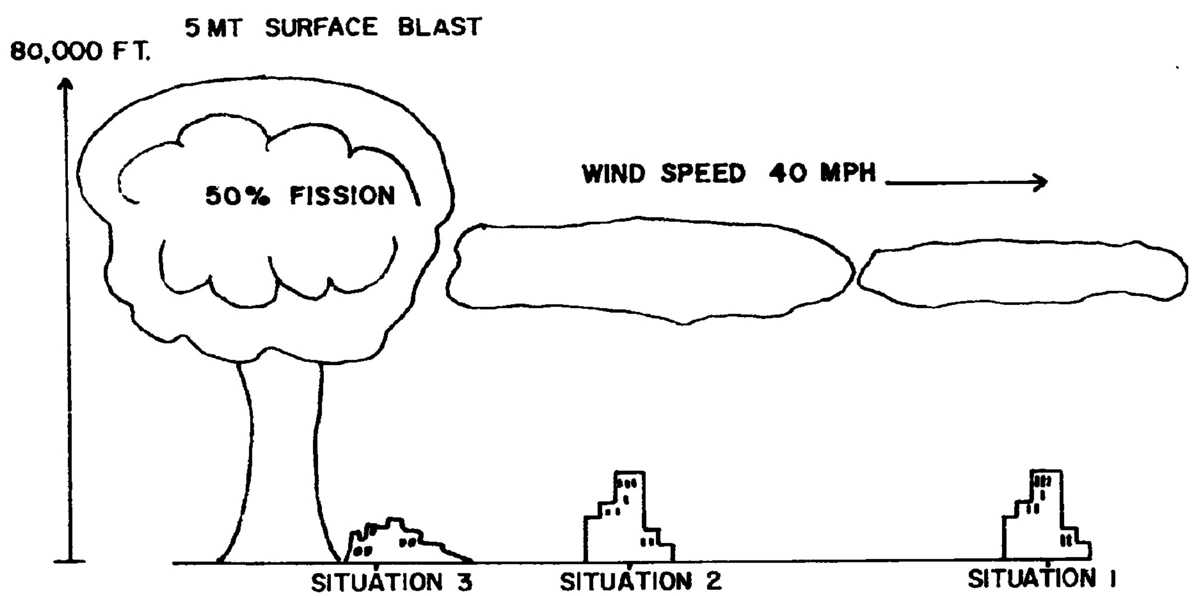

FIGURE B-1

PROPORTION OF EXPOSED POPULATION FATALLY INJURED

BY GIVEN RADIATION DOSES

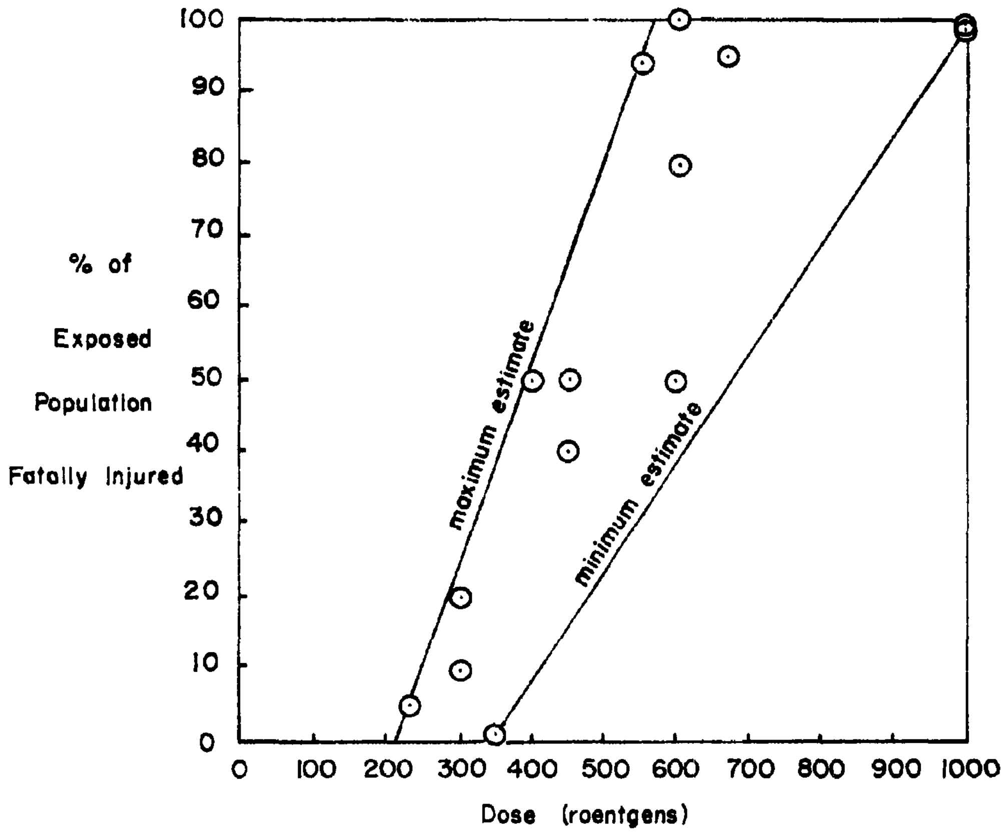

FIGURE B-2

PROPORTION OF EXPOSED POPULATION SICK DUE TO GIVEN RADIATION DOSES

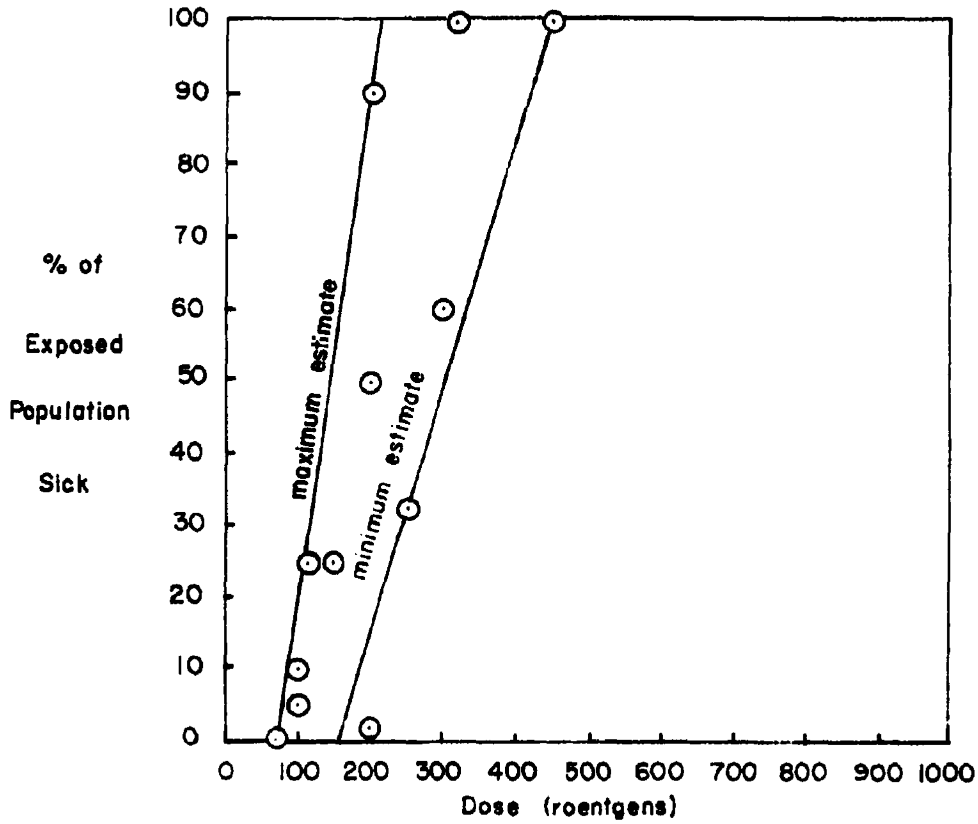

FIGURE B 3

TABLE B-III

Summary of Total Four Day Dose Received by Shelter Occupants According to Shelter Distribution*

SITUATION	Total Dose (roentgen)	Assumed Protection Factor of Shelters** 30	55	85	100	TOTAL NUMBER OF PERSONS
Total Persons in Each Category		41,500	22,600	9,700	26,200	100,000
Situation A (H+1=750 r/hr; T_e=4.15 hrs.)						
Total 4-day dose	1,300r	43	23	15	13	--
Persons Sick	-	-	-	-	-	none
Persons Fatally Injured	-	-	-	-	-	none
Situation B (H+1=2500 r/hr; T_e=2.15 hrs.)						
Total 4-day dose	5,600r	187	102	66	56	--
Persons Sick	-	37,000	3,400	-	-	40,400
Persons Fatally Injured	-	-	-	-	-	none
Situation C (H+1=10,000 r/hr; T_e=.35 hrs.)						
Total 4-day dose	27,000r	900	490	318	270	--
Persons Sick	-	41,500	22,600	9,700	26,200	100,000
Persons Fatally Injured	-	41,500	18,100	2,900	3,940	66,440

* The numbers of sick and fatally injured were computed using the maximum estimate curves in Figure B-3. Direct weapons effects casualty estimates have not been included.

** In order to obtain a reasonable estimate of total four-day dose, the midpoint of the PF ranges were used except for categories 100 PF and above. Here the PF of 100 was used which tends to overestimate casualties in this category.

Appendix C

DEVELOPMENT OF AN ANALYTICAL MODEL FOR EVALUATING SUPPORT STRATEGIES

In the text we have discussed the relative merits of several strategies of medical support in terms of survival and in terms of the appropriateness of care from the viewpoint of peacetime standards. In this Appendix we will discuss the inter-relationships between the parameters in the abbreviated form of a mathematical model. The model has been kept as simple as possible because of the inherent crudeness of the data.

Assumptions

Because comprehensive analysis of alternative medical support measures in a fallout situation is essentially a complex question involving many unknowns, we have made the following restrictive assumptions:

1. Layman care is available in all shelters (layman care is here defined as care provided by a layman skilled in first aid or trained in medical self-help).

2. The number of people in a shelter is proportional to the number of spaces in the shelter.

Definitions

Medical Care Requirements (See Part II)

Hospital Cases - cases which by peacetime standards "require" hospital level care for appropriate diagnosis and treatment.

Physician Cases - cases which by peacetime standards "require" physician care for appropriate diagnosis and treatment.

Layman Cases - cases which by peacetime standards "require" paramedical or lay care (dentist, veterinarian, layman skilled in first aid) for appropriate diagnosis and treatment.

Shelter Medical Characteristics

Hospital Shelter - a public fallout shelter located in a non-Federal general hospital. Spaces in such a shelter will be referred to as hospital shelter spaces.*

Physician Shelter - a public fallout shelter which has been assigned one or more physicians and nurses. Spaces in such shelters will be collectively referred to as physician shelter spaces. The supply requirements of such shelters are listed in Part II, Appendix C.

Layman Shelter - all public fallout shelters are assumed to be layman shelters, i.e., have at least one person skilled in first aid with a standard first aid kit available.

Medical Care Provided

Hospital Care - normal hospital care as practiced in peacetime. The chief characteristic of hospital care is the availability of extensive diagnostic and treatment equipment, and facilities.

Physician Care - care provided by a physician using the supplies described in Appendix C of Part II.

Nurse Care - care provided by a nurse after the diagnosis has been made by a physician employing the same supplies as for physician care.

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* Federal and non-Federal hospitals are generally identified separately in most available hospital data.

<u>Appropriate Care</u> - care provided which is appropriate to the peacetime requirements of the caseload, e.g., provision of physician or hospital care to <u>physician cases</u> will be considered <u>appropriate</u>. Cases occurring in or transferred to shelters with appropriate capabilities are <u>appropriately</u> treated.

<u>Physician Shelter Assignment Strategy</u> - the strategy of assigning physicians to public shelters and/or hospitals prior to arrival of fallout. The optimum strategy is considered to be that which results in the fewest physician casualties and greatest proportion of shelter spaces in <u>physician shelters</u>.

Notation

The parameters considered in the model are identified in the following description of the notation.

P = total population

N_c = proportion of the population which are medical cases

S_p = proportion of shelter spaces which are physician shelter spaces (see the list of definitions in previous section).

S_h = proportion of shelter spaces which are hospital shelter spaces

C_{pm} = proportion of cases which are layman cases

C_p = proportion of cases which are physician cases

C_h = proportion of cases which are hospital cases

A = expected proportion of cases receiving appropriate care

$\bar{D}_p$ = average distance from a person to the nearest physician shelter

$\bar{D}_h$ = average distance from a person to the nearest hospital

D = expected total distance required to transfer cases with inappropriate care to shelters with appropriate care

D* = expected total distance required to transfer cases with inappropriate care to physician shelters

$\bar{M}$ = average communication time required for a two-way medical message

M = expected number of communication hours to provide medical consultation to cases receiving less than physician care

V_{pm} = proportion of layman cases which survive

V_p = proportion of physician cases which survive

V_h = proportion of hospital cases which survive

V = proportion of all cases which survive

The following matrix completes the notation:

	Survival With Layman Care	Survival With Physician Care	Survival With Hospital Care	All Cases
Total Cases	f	-	-	a
Hospital Cases	g	k	q	b
Physician Cases	h	m	-	c
Layman Cases	i	-	-	e

Consequences of Model

The following relations hold:

$$A = C_{pm} + C_pS_p + C_hS_h = 1 - C_p - C_h + C_pS_p + C_hS_h \quad \text{(C-1)}$$

$$D = PN_c\ (C_p(1-S_p)\ \bar{D}_p + C_h(1-S_h)\ \bar{D}_h) \quad \text{(C-2)}$$

$$D^* = PN_c\bar{D}_p\ (1-C_{pm})\ (1-S_p) \quad \text{(C-3)}$$

$$M = PN_c\bar{M}\ (1-C_{pm})\ (1-S_p) \quad \text{(C-4)}$$

$$V_{pm} = \frac{i}{e} \quad \text{(C-5)}$$

$$V_p = \frac{1}{c} (h + (m-h)\ S_p) \qquad (C-6)$$

$$V_h = \frac{1}{b} (g + (k-g)\ S_p + (q-k)\ S_h) \qquad (C-7)$$

$$\begin{aligned} V &= C_{pm} V_{pm} + C_p V_p + C_h V_h \\ &= \frac{e}{a} V_{pm} + \frac{c}{a} V_p + \frac{b}{a} V_h \\ &= \frac{1}{a} (f + S_p\ (m + k - h - g) + S_h\ (q - k)\ ) \qquad (C-8) \end{aligned}$$

Solution of the Model for a Standardized Urban Area

We shall now evaluate the above formulas using the numerical values presented in Appendix B and Part II for C_{pm}, C_p, C_h, S_h, and S_{pi}, and the caseload $N_c = .1$. These values, it is here recalled, are: $C_{pm} = .43$; $C_p = .46$; $C_h = .11$; $S_h = .04$; $S_{p1} = .34$; $S_{p2} = .32$; $S_{p3} = .04$; $S_{p4} = .54$.

Quantity	Definition	Physician Shelter Assignment Strategies			
		1	2	3	4
$A = C_{pm} + C_p S_p + C_h S_h$	Cases receiving appropriate care (Proportion of all cases)	.59	.58	.45	.68
$PN_c \bar{D}_h C_h (1-S_h)$	Total distances required to transfer hospital cases to hospital shelters (total miles)	1600	1600	1600	1600
$\frac{PN_c \bar{D}_h C_h (1-S_h)}{15}$	Total vehicle hours required to transfer hospital cases to hospital shelters (total miles/15mph)	110	110	110	110
$PN_c \bar{D}_h C_p (1-S_{pi})^3$	Total distance required to transfer physician cases to physician shelters (total miles)	2000	2200	6000	700

Quantity	Definition	Physician Shelter Assignment Strategies			
		1	2	3	4
$\frac{PN_c\bar{D}_hC_p(1-S_{pi})^3}{3}$	Total hours of exposure required to transfer physician cases to physician shelters (total miles /3 mph)	700	700	2000	200
$D^*=PN_c\bar{D}_h(1-C_{pm})(1-S_{pi})^3$	Total distance required to transfer non-paramedical cases to physician shelters (total miles)	2500	2700	7500	800
$\frac{PN_c\bar{D}_h(1-C_{pm})(1-S_{pi})^3}{3}$	Total hours of exposure required to transfer non-paramedical cases to physician shelters (total miles/3mph)	800	900	2500	300
$D=PN_c\bar{D}_hC_p(1-S_{pi})^3+C_h(1-S_h)$	Total distance required to transfer non-paramedical cases to appropriate shelters (total miles)	3600	3800	7600	2200
$M = PN_c\bar{M}\ (1-C_{pm})(1-S_p)$	Total communications hours required for consultation with cases not in appropriate shelters	900	1000	1400	700
$V = C_{pm}V_{pm}+C_pV_p+C_hV_h$	Proportion of all cases surviving	.89	.89	.87	.91

The numerical values derived above are used in the body of this report in evaluating the four strategies tested.

Appendix D

MINIMUM TIMES AFTER ATTACK IN WHICH PATIENTS CAN BE SAFELY TRANSFERRED FROM SHELTER TO MEDICAL CENTER

In determining the feasibility of transferring a patient from a fallout shelter to a medical center, an essential consideration is the extra radiation to which the patient (and the persons transferring the patient) will be exposed. In cases where the shelter has a high protection factor, the radiation received while traveling from shelter to medical center is considerably more than the amount received inside the shelter during the same time period. In order to keep the amount of extra radiation within acceptable bounds, the time of departure from the shelter must be delayed until sufficient decay of fallout has occurred.

Several factors determine the total dose of fallout radiation received in two weeks by a patient who is transferred. These factors can be reduced to the following five variables: 1) the unit-time reference dose rate (we shall use for this quantity the dose rate at one hour after the explosion); 2) the protection factor of the shelter; 3) the protection factor of the medical center; 4) the travel time (i.e., the time required to travel from the shelter to the medical center); and 5) the time of departure from the shelter. We shall determine the departure time as a function of the remaining four variables, subject to the constraint that the total dose over a two week period should not exceed a specified dose (100 roentgens).

An analytical expression exists for determining approximately the total radiation dose D received between the times t_1 and t_2 as a function of the unit time reference dose rate I_o.

$$D \approx I_o \int_{t_1}^{t_2} t^{-1.2}\, dt = 5\, I_o\, (t_1^{-.2} - t_2^{-.2}) \qquad \text{(D-1)*}$$

and it is applicable when t_1 .5 hour and t_2 200 days (Reference 7). The exponent -1.2 characterizes the decay rate, and although this particular value does not hold in every situation, it is a reasonable average. If the protection factor of the shelter is P_1, and the protection factor of the medical center is P_2, it then follows that the total dose D received in two weeks by the patient if he leaves the shelter at time T_s and spends time T traveling from shelter to medical center is given by

$$D \approx K + \frac{I_o}{P_1} \int_{\frac{1}{2}\text{hour}}^{T_s} t^{-1.2}\, dt + I_o \int_{T_s}^{T_s+T} t^{-1.2}\, dt + \frac{I_o}{P_2} \int_{T_s+T}^{336\text{hours}} t^{-1.2}\, dt \qquad \text{(D-2)*}$$

where I_o is the unit time reference dose rate (in hours) and K is the dose received in the first half hour after the explosion. Performing the integration, we have

$$D \approx K + \frac{5I_o}{P_1}\,(.5^{-.2} - T_s^{-.2}) + 5I_o(T_s^{-.2} - (T+T_s)^{-.2}) + \frac{5I_o}{P_2}(T_s+T)^{-.2} - 336^{-.2}). \qquad \text{(D-3)*}$$

When T is small compared to T_s, and if $P_1 = P_2 = P$, say, then we have the further approximation

$$D \approx K + \frac{5I_o}{P}\,(.5^{-.2} - 336^{-.2}) + I_o T\, T_s^{-1.2} \qquad \text{(D-4)*}$$

---

* The above relations are reported in Reference 7.

In constructing the following graphs, it is assumed that the protection factors of both the shelter and of the medical center is 100; minimum departure times for buildings with higher protection factors will be somewhat shorter. We shall consider travel times up to 3 hours. Requiring $D \leq 100$ r, the following graphs then give the minimum acceptable departure time, T_s, as a function of travel time, T, and the unit-time reference dose rate, I_o, at one hour after the explosion. For Figure D-1, all fallout is assumed to have arrived at time $t_e = 1$ hour; for Figure D-2, $t_e = 4.15$ hours; for Figure D-3, $t_e = 2.15$ hours. (Figures D-2 and D-3 depict situations A and B described in Appendix B).

Figure D-1

Plot of Travel Time versus Minimum Departure Time and Unit-Time Reference Dose Rate (I_o) at one hour after explosion.

Effective time of arrival of fallout is t_e = 1 hour.

Protection factor of shelter and of hospital is 100.

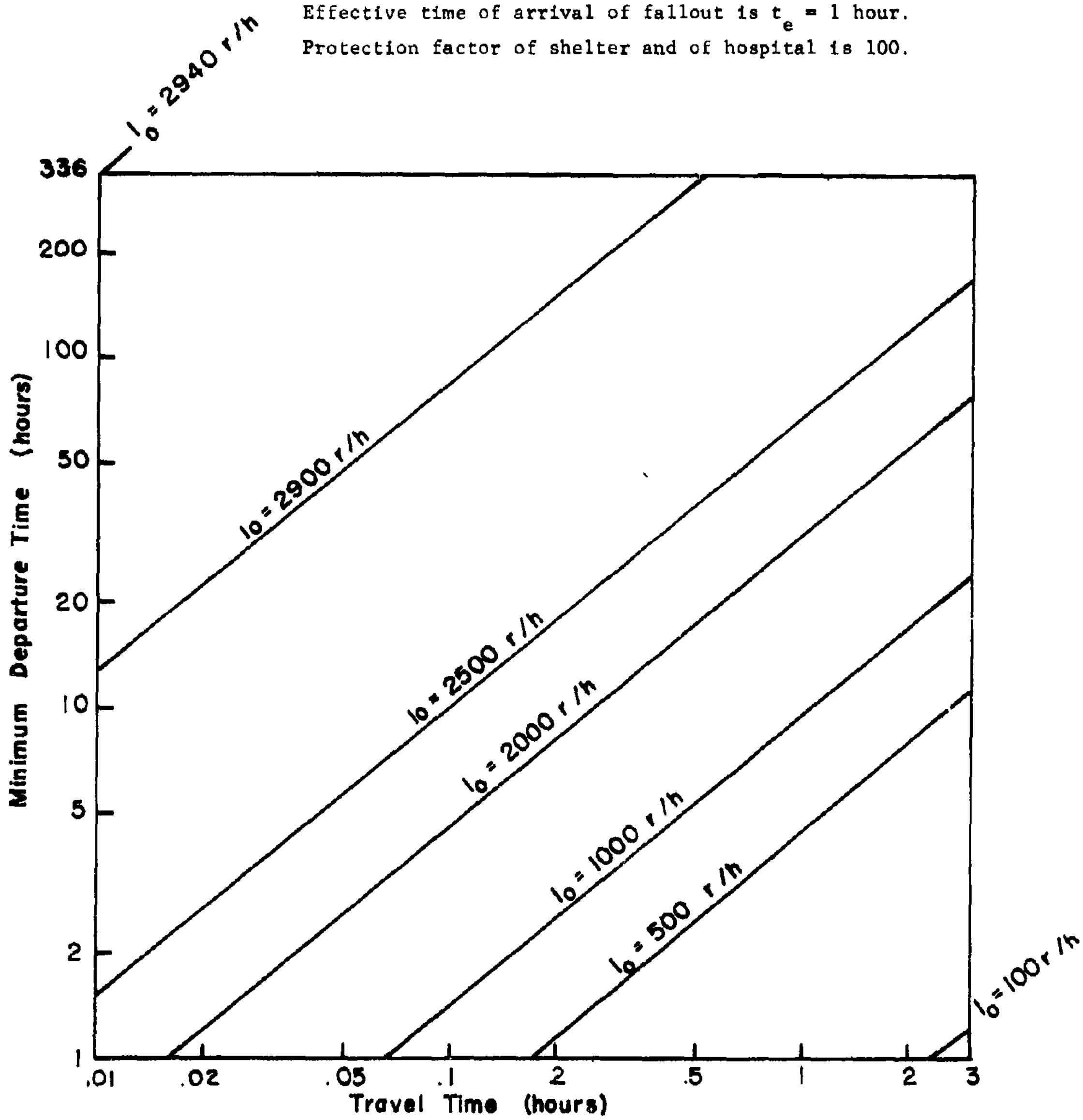


Figure D-2

Plot of Travel Time versus Minimum Departure Time and Unit Time Reference Dose Rate (I_o) at one hour after explosion.

Effective time of arrival of fallout is t_e = 4.15 hours.

Protection factor of shelter and of hospital is 100.

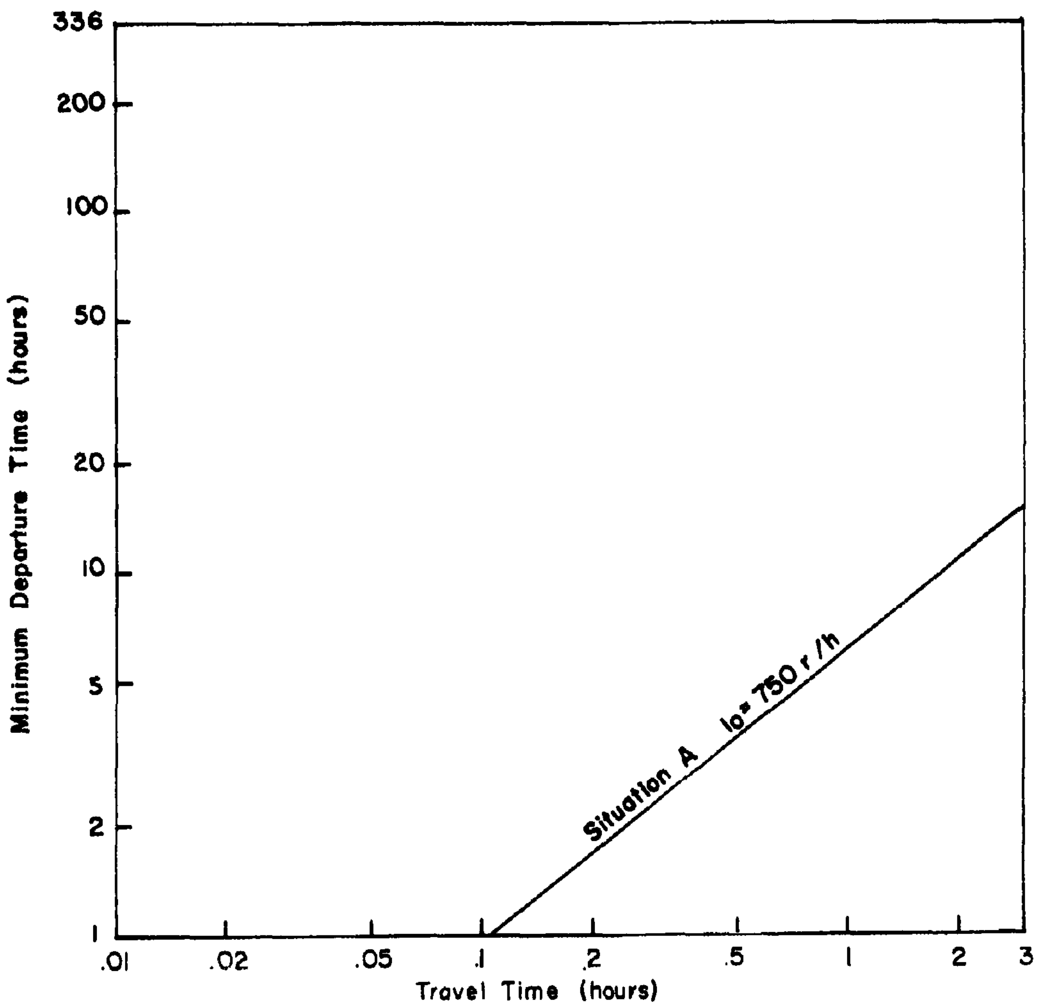
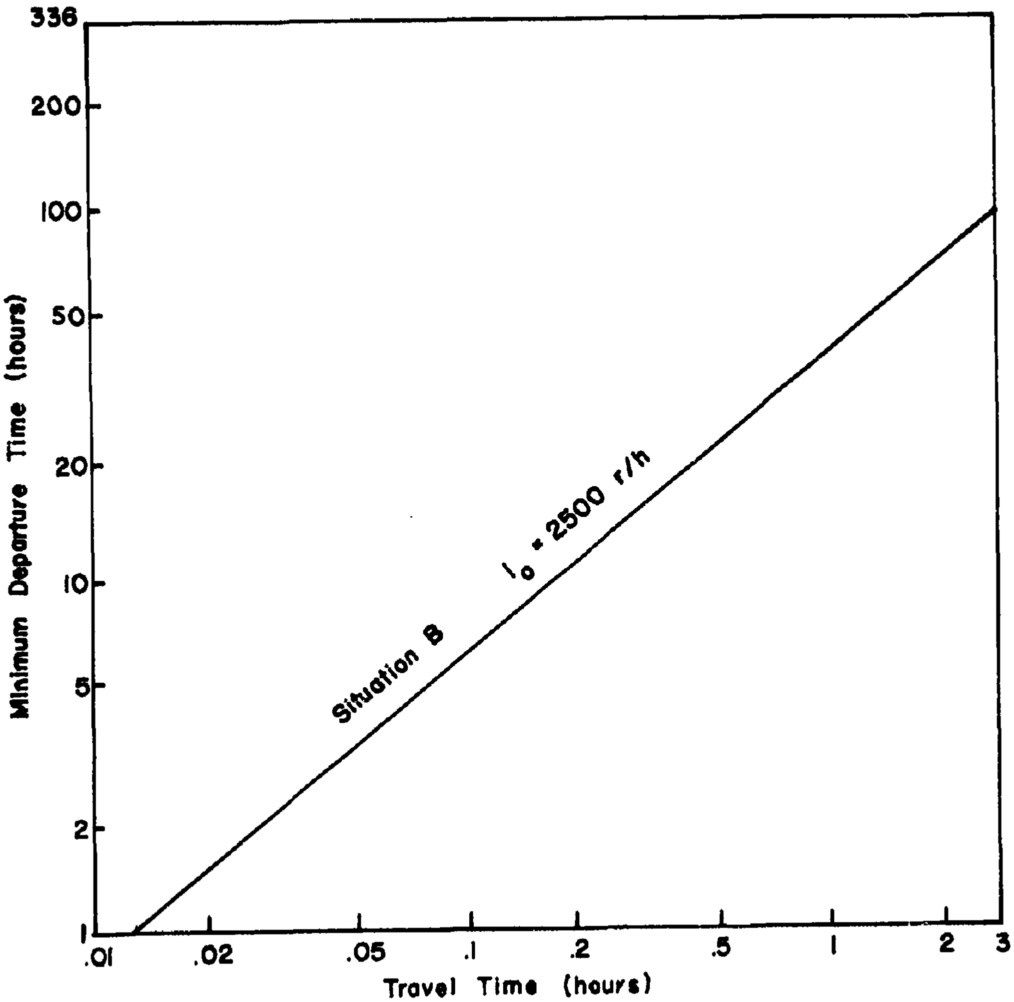


Figure D-3

Plot of Travel Time versus Minimum Departure Time and Unit Time Reference Dose Rate (I_o) at one hour after explosion.

Effective time of arrival of fallout is t_e = 2.15 hours.

Protection factor of shelter and of hospital is 100.



Appendix E

REMOTE DIAGNOSIS AND TREATMENT: A PRELIMINARY REVIEW

Introduction

This Appendix was originally prepared as RTI Research Memorandum OU-107-3. The information is included in this report because it reviews the results of a comprehensive search for information on the possibility of using communication media in medical diagnosis and treatment, here referred to as remote diagnosis and treatment systems. Existing systems are discussed in connection with the application of remote diagnosis and treatment as a technique for providing medical support to a population confined to an area network of fallout shelters. Suggestions for development of the system as an operational part of the general civil defense medical plans are outlined and the necessary tools and background research needs are described.

General Description

The various techniques for providing medical support to a community in the possible range of postattack environments are all subject to constraints of one kind or another. Of these techniques, only two are not seriously subject to the mobility constraints originating from heavy fallout: (1) assignment of medical personnel to shelters prior to arrival of fallout; and (2) remote diagnosis and treatment. The characteristics and limitations of the assignment technique are

discussed in the text of this report; however, its principal limitation is the need for adequate warning time prior to arrival of fallout.

The technique of remote diagnosis and treatment involves communication between shelters and an external medical service for the purpose of medical advisory services. A layman in the shelter would make obervations about a patient's condition, report these to one or more doctors by telephone or radio, and then apply the particular treatment suggested. The essential elements of such a system would include: (1) a communications system; (2) a qualified physician; and (3) adequate medical supplies in the shelter to carry out the suggested treatment. In order to fully exploit these resources, a well developed technique for examining the patient and transmitting the necessary information rapidly and unambiguously would be essential.

Feasibility and Effectiveness

In attempting to arrive at some estimate of the feasibility and probable effectiveness of the remote system, inquiries were made throughout the world where it was believed that such systems might be in use. The replies received described remote diagnosis systems which are in use in such places as Alaska, Canada, Australia and Puerto Rico (see References 19 - 25). The most elaborate system reported was that of the International Radio-Medical Center (CIRM) operating in Rome, Italy. This system has a panel of 50 physicians which provides radio assistance to merchant ships of all nationalities. CIRM provides the ships with an instruction book for observing the patients, transmitting the information in telegraphic code, and interpreting abbreviated treatment messages.

From the existence of such remote systems it seems reasonable to conclude that the technique is feasible and effective in peacetime situations, though the

quantitative effectiveness remains to be established. As brought out in Section IV of the text, the overall demand on communications in a civil defense emergency indicates that communications would be greatly overloaded and may not be available for transmission of medical messages.

Fallout Shelter Remote Diagnosis and Treatment System

The initial step in developing a minimal remote diagnosis and treatment technique into an operational system would be the construction of the written instructions and record forms. These would include two packets as described below. Later efforts would involve training and implementation of the system in the overall operational plans. The general operation of the system is summarized in Figure E-1.

1. SHELTER MEDICAL REMOTE DIAGNOSIS AND TREATMENT PACKET

   (a) Contents

      (1) Instructions and Record Forms for Examination of Patients

      (2) Medical Transmission Forms with Instructions

      (3) List of Standard Treatment Procedures with Instructions

      (4) List of Remote Diagnosis and Treatment Stations (To be supplied by the local civil defense agency)

   (b) Location

      To be stocked in public fallout shelters and distributed to other shelters as requested.

2. REMOTE DIAGNOSIS AND TREATMENT STATION

   (a) Contents

      (1) Medical Record Forms (identical to Medical Transmission Forms stocked in shelters)

(2) Diagnosis and Treatment Records

(3) List of Standard Treatment Procedures and Instructions

(4) Inventory of Shelter Medical Characteristics - includes descriptions of the contents of the Shelter Medical Kits and supplementary information as provided by the local civil defense agency.

(b) Location

To be stocked and distributed to hospitals, medical personnel, etc.

Conclusions and Recommendations

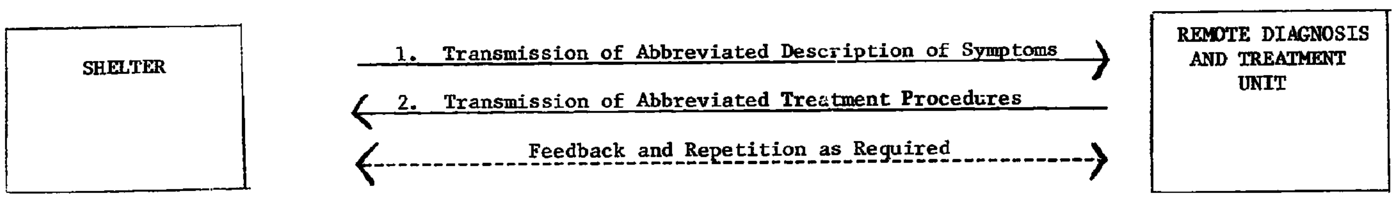
The preliminary research on the remote diagnosis and treatment system has indicated that such a technique is generally feasible and effective in peacetime, as demonstrated by its use in remote areas of the world and for ships at sea. While it would be difficult to predict the quantitative level of effectiveness of remote diagnosis and treatment, the following arguments for incorporating such a system into the fallout shelter program are evident:

1. The system could be operable during heavy radioactive fallout at times when even brief external exposure for rescue or emergency action would be prohibited. In this regard, it is one of very few medical support techniques which are not sensitive to fallout constraints. It is subject to constraints on the communications system.

2. The tools developed for this system would be applicable to other medical support techniques including: (a) assisting shelter occupants in diagnosing the patients if remote aid were not available; (b) furnishing information to medical centers which would enable them to assess the overall medical status of the community and to select

FIGURE E-1

General Operation Of The Remote Diagnosis And Treatment System



SHELTER

1. Procedural Steps:

   (a) Examine patient and complete Medical Diagnosis Information Form

   (b) Abbreviate information for transmittal

   (c) Transmit message (s)

   (d) Apply suggested treatment using standard instructions when feasible

   (e) Observe progress of patient and report if patient does not respond

2. Description:

   Any shelter with necessary instructions and communications equipment. The available supplies might include those available in the shelter medical kit or those which might be available in the shelter building (pharmacies, physicians' offices, dentists' offices, building first aid supplies, etc.)

REMOTE DIAGNOSIS AND TREATMENT UNIT

1. Procedural Steps:

   (a) Receive message and query for further information if indicated

   (b) Develop tentative diagnosis of each case reported

   (c) Prescribe treatment on the basis of knowledge of shelter medical supplies using Standard Treatment Procedures

   (d) Abbreviate treatment instructions

   (e) Transmit message (s)

   (f) Repeat procedure if necessary

2. Description:

   The remote diagnosis and treatment unit could be any facility with a physician present, the necessary instructions and information, and communications capability. Such facilities could range in size from a hospital to the family shelter of a physician.

which shelters should receive additional help when feasible; (c) assist medical personnel in deciding which patients require the most immediate attention when medical visits to shelters become possible.

3. The system would be relatively easy to incorporate into current fallout shelter plans once the proper tools had been developed. The costs of implementing and maintaining the system would be relatively inexpensive.

The major argument against incorporation of the system is the probable in-availability of communications for medical purposes during the shelter period.

In general, it should be pointed out that remote diagnosis has been involved in several of the past shelter tests in the form of phone conversations between the shelter managers and the staff monitoring the tests. It can be anticipated (as discussed in the text) that the occurrence of illnesses and injuries in shelters during the postattack period would place considerable demand on available communications, regardless of whether procedures had been established for this specific purpose.

It is therefore recommended that OCD give serious consideration to investigating the probable feasibility and effectiveness of a remote medical diagnosis and treatment system in a range of postattack environments. If such a system were found to be desirable further steps required would include:

1. Preparation of tools and techniques
    - a.) Modification of existing instructions and forms to fit the fallout shelter situation and to be consistent with current plans for in-shelter medical support
    - b.) Development of additional instructions and forms as needed

2. Pre-testing of tools and techniques (the pre-testing procedures could also be used to estimate the probable error of the remote method.)
    a.) Use of the procedures among patients with known diagnosis
    b.) Testing of the procedures in shelter habitability experiments
3. Experimental implementation (prototype implementation of the system in several specific local areas)
    a.) Coordination with responsible health agencies and professional organizations
    b.) Training of lay and professional personnel in use of the technique
    c.) Testing the overall system in conjunction with shelter experiments in order to evaluate the above two steps
4. National implementation.

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Part II

ILLNESS SPECTRUM AND PATIENT CASELOAD DURHAM-ORANGE COUNTY, NORTH CAROLINA

Shelter Medical Support System Study

(OCD Project No. 1341A)

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SHELTER MEDICAL SUPPORT SYSTEM STUDY

(OCD Project No. 1341A)

Chapter I

This study considers the practicability of providing medical care during an emergency period in which the general population is confined to a system of shelters of variable composition, and evaluates the influence of medical care at various levels of austerity in relation to added survival. Correlative is the extent to which each shelter or shelter complex can be made medically self-sufficient through the stocking of medical supplies and equipment, assignment of medical personnel, and the assistance of trained persons in the paramedical areas.

Further, can life saved and health preserved be increased by prior provision for hospital care separate from the shelters themselves?

Essential to this study, or to the planning of any medical care program, is a prediction on the size and nature of patient caseload in an area shelter system, including baseline illness and injury.

Injury, Illness, and Disease Spectrum in a "Model" Community

We have arbitrarily chosen the Durham-Orange County community, mainly because of its accessibility to this group of investigators. We wish to emphasize that this community may differ in considerable degree from other possible communities and that our conclusions may not necessarily be applicable to other

urban-rural complexes in North America. We do believe, however, that it is only by examining carefully one population unit, such as this, that one may be in a position to extrapolate, interpolate, or make intelligent guesses about other communities.

The total population of these two counties is approximately 160,000 people, more urban than rural. The ratio of 3 urban to 1 rural citizen is reflected in our total urban-rural patient incidence noted in Table I. The climate is temperate, with an approximate latitude of 36° 00' and longitude of 79° 00', located in the middle Piedmont plateau with elevation of approximately 300 feet. The prevailing wind is southwesterly with periodic intrusions from the northeast, mainly during the winter.

From the medical point of view this community may be somewhat unusual in that it contains two A grade medical schools, and one of the outstanding schools of public health in America, with consequent readily available illness data in the county health departments and local welfare agencies. There are seven hospitals in the area including two university hospitals, two private community hospitals, one Veterans Administration hospital, and a tuberculosis sanatorium. The seventh hospital deals with a limited number of specialties in opthalmology and otolaryngology. This total daily active hospital census as noted in Table II is 2,038 patients.

Our first goal was to determine incidence of serious injury or illness in the community as distinguished from the day to day non-emergency sickness of a nature not requiring urgent care and whose sequelae are usually non-fatal. We believed that the most accurate answer to this question could be obtained by making a survey of daily emergency room visits to each of four of the larger

community hospitals, namely: Duke Hospital, Lincoln Hospital, North Carolina Memorial Hospital, and Watts Hospital. For a sample, twenty-four hour emergency room admission cases in these hospitals were obtained for the quadrantic months of October and December 1961, and March and July of 1962. The variation in number of college students available is minimal since summer sessions are a common practice. Each case was classified by a primary diagnosis and the number and breakdown by month and institution is contained in Table III. For the purpose of diagnostic codification we used Volume I, INTERNATIONAL CLASSIFICATION OF DISEASES, ADAPTED, U. S. Department of Health, Education and Welfare, Public Health Service Publication No. 719, Revised Edition, December 1962. The original total of 15,398 was reduced for working purposes to 13,959 by deletion of three categories that could not be satisfactorily diagnosed. These were: dead on arrival, 42; unspecified accidents, 191; and special admissions, 1,206 (see Table IV).

The seasonal spread of visits was approximately 20 per cent less for December and March than the other two months (see Table IV). The incidence of urban to rural was 3:1 (Table I), although in later analysis of the illness spectrum there was no significant difference in urban versus rural illness spread. Visits for all age groups were greatest in October, (Table IV). This is a cultural phenomenon long recognized in this area, related to agricultural and tobacco harvest.

In Table V, the cases are considered by age group and it will be noted, as expected, that the largest numbers of injury and illness per year age occur in the age group 2 to 14 and the next more frequently in the active and productive age group 15 to 44. Table VI indicates the number of emergency room visits in

I.C.D.A. categories by month. Attention is directed to the fact that one third of all visits were due to trauma. Table VII contains a breakdown of categories and sub-categories and will be considered more specifically under a rearrangement of this entire emergency room case study, together with important additions, not contained in this Table, namely: Durham-Orange County Public Health Department data on infectious disease, obstetrical deliveries, live births, and deaths.

Other Sources of Illness Spectrum

Table VIII contains the 1962 number of births and infant deaths. These data were obtained from the local Public Health Department vital statistics tables. Table IX enumerates the number and cause of resident deaths in Durham and Orange Counties for the year 1962. An I.C.D.A. breakdown of chronically ill patients at home is shown in Table X. Of interest regarding a significant latent illness was a recent survey of 20,000 people in these two counties for the presence of glaucoma. This prevalence proved to be 2 per cent or 3,200 people in the total population. In Table II, rest home residents are enumerated, indicating 467 for the two counties. All of these persons are invalid or semi-invalid.

Table II also enumerates the average daily census for all hospital units within the area for a total, previously noted, of 2,038. If one scrutinizes this total figure closely, it must be admitted that approximately 25 per cent of the patients in Duke Hospital, North Carolina Memorial Hospital, and the Veterans Administration Hospital come from locations within these two counties, whereas approximately 75 per cent of the patients in these hospitals come from

more distant locations. As far as our local problem is concerned, however, the total figure seems to be a realistic one inasmuch as on any given day this area would be burdened with this number of hospitalized bed patients. Moreover, cessation of transportation would prevent evacuation of any of these patients to shelters near their homes.

A one day total patient census for North Carolina Memorial Hospital was made, using I.C.D.A. Coding (See Appendix B). This single pilot study was made for two reasons: first, to determine how nearly the local one day patient spectrum coincided with the emergency room case study and with comparison to other hospital and community studies elsewhere in this country and in Great Britain on local and national bases; and, second, to determine a hospital estimate of categories of illness for purposes of triage. The subject of patient categories will be defined and clarified presently.

Limitation of time prevented a one day census sampling in the other hospitals.

The I.C.D.A. breakdown for the emergency room case study is presented in detail in Appendix A (Emergency Room Case Study) together with anticipated numbers of patients for a two week period based on total population.

Bed occupancy from all sources in hospitals and <u>homes</u>, is presented in Table II for a daily Durham-Orange County total of 4,750.*

Category Breakdown

The emergency room case study is primarily one of illness spread or spectrum. This study is intended to catch all seriously ill or injured people in

* Average in-patient stay 1962-1963: Duke Hospital, 9.9 days; Lincoln Hospital, 8.4 days; N. C. Memorial Hospital, 9 days; Veterans Administration Hospital, 25 days; Watts Hospital, 7.6 days.

these two counties who are referred by physicians, go to an emergency room of their own volition, or are carried by ambulance, police, or other individuals or agencies. The second part of the study is concerned with sick people in hospitals, nursing homes, and at home. This provides additional information on the daily case bed load, and also contributes to the illness spectrum. Although both groups referred to above are for obvious reasons considered separately, they are both classified by the INTERNATIONAL CLASSIFICATION OF DISEASES (PHS Publication No. 719). Using this classification both groups of patients, emergency room cases and daily bed patients, are divided into five triage subcategories. Refer again to the Tables for the Emergency Room Case Study and the one day patient spot check for North Carolina Memorial Hospital in Appendix B.

Category 1 refers to all patients in the I.C.D.A. Code who could not be adequately or properly treated except in a modern, sophisticated, medical hospital complex.

Category II refers to those patients who could conceivably be treated at home or in an "adequate" shelter under the care of sufficient well-trained physicians and paramedical personnel with appropriate drugs, dressings, technical, and hardware equipment.

Categories III and IV could not be practically separated and refer to that group of patients who could be taken care of by a dentist, a competent nurse, or other highly skilled non-medical specialist, gradually declining in medical complexity to include paramedical personnel, such as technicians, practical nurses, orderlies, boy scouts and midwives. Here also one would find the widest latitude in available drugs, dressings, and other equipment.

In all of these categories circumstances would obviously shift from one level to another depending on the austerity of the situation. To begin with, at any rate, the picture is looked at through the eyes of civilians in a peaceful world.

Category V contains those cases from all I.C.D.A. Codes who under ideal conditions should either be isolated, restrained, or sequestered. An example of isolation would be represented by the presence of a person or persons with tuberculosis, diphtheria, measles, etc. Those requiring restraint would represent the acute alcoholic, major psychosis, or, most especially, the sociopathic personality. Sequestration obviously refers to the dead.

Using this classification and referring to the caseload of 4,750 bed patients entering shelters from all sources we see from Table XI that 9 per cent would fall in Category I, 53 per cent in Category II, and 38 per cent in Category III and IV. Table XII shows a projected caseload from all categories entering shelters for a two week period. These figures are derived from the emergency room case study in Appendix A, extrapolated for a two week span of time. One will note that for Category I the percentage is approximately 11, for Category II, 46, and for Category III and IV close to 44 per cent. These latter percentages are remarkably close to the category percentages of the permanent daily overall bed case population. Even though the size of the samples are different the uniformity of percentages in both groups suggests the dependability of this category system of triage.

Category V is the most difficult to predict, and therefore, will be considered separately. During periods of peace and in a constant population without epidemic the death rate should be fairly constant. For this study area the number of deaths averages 101 per month or 3.3 per day. This number would vary significantly depending on the handling of Category I and II patients and the incidence of epidemic under shelter conditions. Unpredictable variants would include the incidence of trauma, which might be expected to decrease. On the other hand, the increase in respiratory and enteric infection, because of short incubation period, might more than offset a decrease in injury. Similar prediction difficulties relate to isolation per se, as well as restraint.

Chapter II

Degrees of austerity in shelter medical care are considered below.

Added death estimates for the 160,000 population of Durham-Orange County during a two week period of shelter confinement are examined under the following conditions, namely: estimated deaths with no treatment, estimated deaths with attending physicians in shelters provided with basic drugs and equipment, estimated deaths with nurses or their equivalent in attendance in shelters having available basic drugs and equipment, and estimated deaths with the well portion of the population in shelters and the sick left undisturbed in hospitals whose personnel and equipment are intact.

The Emergency Room Case Study is the basis for all extrapolations, with added death estimates made on the individual evaluation of the disease or injury subheadings in each triage category. See Appendix A and Table XIV for these estimated case-fatality ratios for each diagnosis.

The basic patient load from all sources for day "X" plus two weeks for the approximate population of 160,000 people is presented in Table XIII. This includes all sick or invalid patients in hospitals or beds and lesser treatment facilities, plus a projection from the Emergency Room Case Study to indicate the numbers of additional injured or ill people that would develop during two weeks in a shelter. These figures of 4,750 hospital and bed patients plus 1,991 developing in two weeks are actually derived from Tables II and XII respectively.

This makes a total two week patient caseload of 6,741 or 4.21 percentage of the total population.

The percentage death estimates for each category with no treatment resulted from estimating the number of deaths in each disease or injury heading. For example, in Category I, estimated deaths for a two week period without treatment numbered 90 in a total of 214 Category I patients, a percentage of 42 in this category. Similar estimates and calculations were made for the other three categories and are tabulated in Table XIV. These percentages from the Emergency Room Case Study estimate for deaths without treatment were multiplied by the triage categories for patients in hospitals and beds. The number of estimated deaths in both groups are presented in the above table.

One will note that the estimated deaths without treatment for a two week period from the general population who can be expected to become ill or injured numbers 255, and for those confined to beds and hospitals, the number is 637. Added, a total of 892 deaths derives from all sources, or a percentage of 0.56 of the total population. Baseline deaths are 49 per two week period in the total 160,000 population and their presence is implied in all calculated totals.

The details of this calculation will not be repeated for subsequent estimates, but it is felt important to emphasize our technique of extrapolation for purposes of criticism and comment.

Table XV presents the expected deaths during a two week period with attending physicians and medical supplies in shelters. The extrapolation is derived from Appendix A. The basic drugs and equipment referred to are enumerated in Appendix C. Each item was selected for maximum value based on illness or injury

in relation to triage category. This list is copied from no other, being tailored absolutely to the illness spectrum presented. No brief is made for this list and it should be emphasized that it could be abbreviated or expanded for reasons of utilitarianism. Usefulness of such supplies as instruments, dressings and splints would depend on sophistication and quantity in addition to semiprofessional assistance and cleaning for re-use. The appropriate choice of such antibiotics as penicillin, tetracycline, and chloroamphenicol would depend on a high degree of microbiological assistance.

Total deaths under circumstances approximating the above would total 383 or 0.24 per cent of 160,000 people.

Table XVI summarizes the expected deaths for a two week period where nurses or their equivalent are in attendance with the medical supplies available mentioned above. The bases for the extrapolations presented are contained in Appendix A. The deaths under these circumstances total 453 patients, or 0.28 per cent of 160,000 people.

Expected Deaths for Bed and Hospital Patients Whose Facilities for Treatment Are Left Undisturbed

The anticipated illness and injury load from all sources for a two week period is 6,741 patients of whom 4,750 derive from patients within hospitals or other facilities. Since this latter figure represents 70 per cent of the entire anticipated caseload, one raises the question as to how much the overall mortality could be reduced by leaving hospitals and other semi-medical facilities and their personnel intact, and their patients undisturbed, in contrast to movement into shelters or by following the present policy of designating hospitals simply as fallout shelters.* By referring to Table XVII, one

* As per: "Guidelines Established for Use of Hospital Shelters," Dept. of Defense, Office of Civil Defense; Information Bulletin #54, 28 Dec., 1962.

can observe that 65 deaths could be anticipated within the two week period as contrasted against 637 deaths with no attention or treatment, 267 deaths with a physician in attendance in shelters possessing basic equipment, and 316 deaths with nurses or their equivalent in shelters containing basic equipment.

Category V

Category V, enumerated at the end of Appendix A, indicates the breakdown for the anticipated patient spectrum who would require isolation, restraint, or sequestration. There would be 228 patient candidates for this category during a two weeks period in this population of 160,000 people. Isolation effectiveness would depend on the degree of austerity. It would be hazardous to anticipate the number of added deaths if isolation were not practiced. One might anticipate that this group would appear insignificant in comparison to the epidemiology of the mass confinement of people in quarters subjected to the greatest propinquity imaginable.

Patients necessitating restraint during a two week period would amount to 20, an insignificant figure in this microcosm.

The sequestration of the dead is another matter. The figure for total annual deaths in Durham-Orange County is established at approximately 1,274. Since this figure is derived from the U. S. Public Health Service National Vital Statistics Division, this number applies only to stated residents of these two counties. This number provides the base line or background death rate of 49 per two week period. A better estimate of expected deaths for a two week period with varying degrees of austerity is presented in Table XVII. The approximate total number would vary from a maximum of 892 to a minimum of 230 based on previous calculations.

History has demonstrated the morale factor of death in the presence of the living in times of disaster. It seems to us that one of the most important considerations in this study concerns disposal or sequestration of the dead. Assuming burial or cremation impractical for reasons of radioactive fall-out, the alternative appears to be the embalming of the dead until their bodies can be removed.

There are 30 licensed embalmers in Durham-Orange County in addition to 721 registered physicians. This would represent a total of 751 persons who, theoretically, should be able to provide embalming. In terms of population spread this would represent one potential embalmer to each 213 people. This figure may not be applicable to other areas because of the high proportions of potential embalmers in this region.

Chapter III

To this point our purpose has been to examine the medical caseload in a "model" community under relatively simple and arbitrary degrees of degradation. In doing this we arrive at conclusions that are not unexpected.

Our data support the suspicion that necessary personal medical care involves a small percentage of a given population. We have made our extrapolations on the liberal side and as can be seen in Table XIII this reaches a total of 6,741 for a population percentage of 4.21.

Another obser- ation is graphically expressed in Table XVIII where we see that if none of this population group requiring medical care were treated, one could expect 892 deaths in two weeks, representing a population percentage of 0.56. With the best possible care now available, in this study, the deaths would drop to 230 persons,* or a population percentage of 0.14. In other words, the most sophisticated treatment available as opposed to no treatment represents a death difference of 711 persons or a percentage of 0.45.

The peacetime medical care we enjoy, exclusive of preventive medical and public health practices, produces minimal yield for maximum performance and monetary expenditure. Furthermore, the concept and practice of personal medical care can almost be reduced to the formula of one patient in one bed in one room being treated by one doctor and one nurse at one time. Departure from this concept was never entirely broken during the most hectic days of combat casualties in World War II.

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* It does not drop to the baseline of 49 deaths because the 49 represents only residents of the two counties whereas 3/4 of the hospitals are treating 75% or more non-residents.

Still looking at our "model" population through the eyes of civilians in a peaceful world, we find two conditions that affect added survival more than anything else. One is provision for infant care and feeding; the other: provision for the continued operation of established medical facilities, <u>as such</u>, wherever possible. The case for the infants does not show up specifically in the Tables; but in Appendix A, Category II, under Deliveries and Complications of Pregnancy, 140 infants could be expected to die within a two week period as against <u>less</u> than 3 with "proper" care and feeding. The former figure represents nearly 15 per cent of the maximum expected deaths of 941 in a two week period. Table XVII illustrates dramatically the extremes of no treatment of hospital and bed patients versus hospital care. Death in this group increased by a factor of 10.

Factors of Deterioration

To this point, nothing has been said about the possible added deaths due to epidemic, heat stroke, and importantly, radiation. How much the threat of epidemics could be attenuated or averted by the large scale use of immunization programs, as practiced by the military; standard decontamination techniques, as the widespread use of DDT; or the prophylactic use of antibiotics on a large scale is impossible to judge. Nor can one venture an intelligent guess as to how much heat stroke could be reduced by use of salt tablets and liberal water supply.

The subject of superimposed radiation from fallout can be considered only with uncertainty.

Theoretically and philosophically, the fallout shelter system is dedicated to that segment of the population left physically undamaged following mass attack, who could <u>ideally</u> obtain sufficient shelter to avoid lethal or disease producing radiation. In probability a shelter population would receive insufficient radiation to alter our predictions, or would be seriously radiated in such numbers that the most sophisticated peacetime medical centers would be unable to alter mortality in our present state of knowledge concerning treatment of severe radiation injury.

The same reasoning prevails with relation to burns and to a lesser degree to blasts; and all known disasters in these areas that have involved more than a few hundred, and at most a few thousand, have taxed beyond capacity available resources.

Chapter IV

Summary and Conclusions

This study describes the illness spectrum and extrapolated caseload for an urban-rural community of 160,000 people. On any given day 4.21 per cent of the population would be sufficiently ill or injured to require medical help. Of this group, 11 per cent would be sufficiently ill to require hospital care. Forty-six per cent could be treated by a physician with appropriate drugs and equipment. Forty-three per cent could be cared for by paramedical persons of less than physician capability, possessing rudimentary supplies. These triage percentages are remarkably constant and could be used to estimate percentage evacuation from hospitals in times of mass disaster.

We consider factors inducing added deaths with varying degrees of austerity in patient care in a peacetime civilian community. This varied from 0.56 per cent of the population with no medical care to a low of 0.14 per cent where the population received maximum or "normal peacetime care." The largest sources of added death were in uncared for or untreated infants, 15 per cent of the total; and the removal of normally operating hospital facilities. This latter situation increased the added deaths by a factor of 10.

The problem of sequestration of the dead is considered.

We have no justification to interpolate the effects of radiation, fire or blast injury into this study. Comments relating to this subject are stated in Chapter III.

Table I

Emergency Room Cases

By Urban or Rural Residence

Residence	Total	1961 - 1962			
		MALE		FEMALE	
		White	Non-White	White	Non-White
TOTAL	13,959	4,604	3,587	2,813	2,955
Urban	10,229	3,355	2,722	1,957	2,195
Rural	3,730	1,249	865	856	760

TABLE II

Total Daily Bed Confinement,

Durham & Orange Counties

Average Daily Census 1962

	Number of Beds Occupied		
	Total	Durham County	Orange County
Total Beds Occupied by Type Facility	4,750	3,790	950
FACILITY			
N. C. Memorial Hospital	405	--	405
UNC Student Infirmary	12	--	12
UNC Gravely Sanatorium	110	--	110
Veterans Administration Hospital	485	485	--
Duke Hospital	592	592	--
Watts Hospital	295	295	--
McPherson Hospital	44	44	--
Lincoln Hospital	95	95	--
Hospital Beds Occupied	2,038	1,511	527
Rest Homes*	467	400	67
Chronically ill at home**	2,245	1,879	366

* Durham and Orange County Welfare Departments, Census 27 May 1963.

** Durham County Health Department (Miss Shirley Callahan); Orange County Health Department (Dr. O. David Garvin).

TABLE III

Total Emergency Room Cases in Four Hospitals,

By Season

Hospital	Total	Months			
		1961		1962	
		October	December	March	July
Total	15,398	4,348	3,380	3,507	4,163
N.C.M.H.	3,655	1,004	842	851	958
Duke	4,288	1,326	851	1,050	1,061
Watts	4,843	1,238	1,070	1,027	1,508
Lincoln	2,612	780	617	579	636

TABLE IV

Emergency Room Cases in Four Hospitals Excluding Cases
Classified as Dead-On-Arrival, Unspecified
Accident, or Special Admissions

Hospital	Total	Months			
		1961 October	December	1962 March	July
Total	13,959	3,933	3,075	3,162	3,789
N.C.M.H.	3,236	896	751	751	838
Duke	3,539	1,068	709	877	885
Watts	4,687	1,211	1,038	989	1,449
Lincoln	2,497	758	577	545	617

TABLE V

Number of Emergency Room Cases in

I.C.D.A. Categories

By Age Group

I.C.D.A. Category	ICDA CODE	TOTAL	Age Group				
			2	2-14	15-44	45-63	64+
Total	000-999	13959	1145	3494	6600	2011	709
Infective & Parasitic	002-138	185	21	86	67	7	4
Neoplasms	140-239	85	5	5	34	26	15
Metabolic Disorders	240-289	418	31	94	167	96	30
Diseases of the Blood	290-299	27	4	8	9	4	2
Mental Disorders	300-329	266	7	6	185	62	6
Central Nervous System	330-398	412	54	115	131	71	41
Circulatory System	400-468	298	8	7	96	117	70
Respiratory System	470-527	1571	339	599	467	126	40
Digestive System	530-587	798	87	145	373	144	49
Genito-Urinary System	590-637	533	19	34	377	86	17
Complications/Pregnancy	640-689	373	13	2	352	5	1
Diseases of Skin	690-716	428	34	115	217	46	16
Diseases of Bones	720-749	186	17	28	86	47	8
Congenital & Early Infancy	750-776	27	22	3	1	0	1
Symptoms, Senility & Other	780-795	2582	305	446	1183	443	205
Injuries & Other	800-999	5770	179	1801	2855	731	204

TABLE VI

Number of Emergency Room Cases in
I.C.D.A. Categories by Month

(Excludes cases classified as dead-on-arrival, unspecified accident, or special admissions)

I.C.D.A. Category	ICDA CODE	TOTAL	Month 1961 October	1961 December	1962 March	1962 July
Total	000-999	13959	3933	3075	3162	3789
Infective & Parasitic	002-138	185	44	56	39	46
Neoplasms	140-239	85	27	19	15	24
Metabolic Disorders	240-289	418	138	86	92	102
Diseases of the Blood	290-299	27	3	10	7	7
Mental Disorders	300-329	266	72	56	62	76
Central Nervous System	330-398	412	97	84	116	115
Circulatory System	400-468	298	90	59	77	72
Respiratory System	470-527	1571	457	407	442	265
Digestive System	530-587	798	230	201	169	198
Genito-Urinary System	590-637	533	141	93	138	161
Complications of Pregnancy	640-689	373	91	95	100	87
Diseases of skin	690-716	428	140	98	64	126
Diseases of bones	720-749	186	42	40	42	62
Congenital & Early Infancy	750-776	27	6	7	6	8
Systems, Senility & Other	780-795	2582	790	490	614	688
Injuries and Other	800-999	5770	1565	1274	1179	1752

TABLE VII

Number of Emergency Room Cases in I.C.D.A.

Categories and Sub-Categories

I.C.D.A. CATEGORIES	I.C.D.A. CODE	TOTAL CASES
All Emergency Room Cases	All	15,398
Total Diseases and Injuries	000-999	13,959
Total Special Admissions	Y00-Y10	1,206
Total Uncoded Accidents	YYY	191
Total Dead-on-Arrival	XXX	42
Infective and Parasitic Diseases	000-138	185
Tuberculosis	002-019	3
Syphilis	020-029	1
Gonococcal & Other	030-039	23
G. I. Infections	040-049	5
Other Bacterial	050-064	29
Spirochetes	070-074	0
Viral Diseases	080-096	100
Typhus & other Rickettsial	100-108	0
Malaria	110-117	1
Other	120-138	23
Neoplasms	140-239	85
Malignant	140-205	43
Benign	210-229	33
Other	230-239	9
Metabolic Diseases	240-289	418
Allergic	240-245	337
Thyroid	250-254	7
Diabetes Mellitos	260	59
Other Endocrine	270-277	6
Avitaminos's & Other	280-289	9
Diseases of the Blood	290-299	27
Mental Disorders	300-329	266
Acute Brain Disorders	300-307	59
Chronic Brain Disorders	308-317	9
Psychotic	318-322	9
Psychophysiological, A & V	323	18
Psychoneurotic	324	128
Personality Disorders	325-328	43
Mental Deficiency	329	0

Continued.

TABLE VII (Continued)

I.C.D.A. Categories	I.C.D.A. CODE	TOTAL CASES
Diseases of the Central Nervous System	330-398	412
Vascular Lesions	330-334	79
Inflammatory	340-345	12
Other	350-357	67
Nerves & Periphery	360-369	20
Inflammatory Eye	370-379	52
Other Eye	380-389	17
Ear & Mastoid	390-398	165
Circulatory System	400-468	298
Rheumatic Fever	400-402	5
Rheumatic Heart Disease	410-416	1
Arteriosclerotic Disease	420-422	79
Other Heart	430-434	66
Hypertensive Heart	442-443	26
Other Hypertensive	446-447	33
Arterial Disease	450-456	10
Veins and Other	460-468	78
Respiratory System	470-527	1571
Acute Upper Respiratory	470-475	1178
Influenza	480-483	57
Pneumonia	490-493	153
Bronchitis	500-502	116
Other Respiratory	510-527	67
Digestive System	530-587	798
Buccal & Esophagus	530-539	109
Stomach & Duodenum	540-545	153
Appendicitis	550-553	101
Hernia, Abdominal	560-561	35
Other Intestinal & Peritoneum	570-578	332
Liver, Gallbladder, Pancreas	580-587	68
Genitourinary System	590-637	533
Nephritis & Nephrosis	590-594	4
Other Urinary	600-609	202
Male Genital	610-617	46
Breast, Ovary, Fallopian	620-626	44
Uterus & Other Female	630-637	237

Continued.

TABLE VII (Continued)

I.C.D.A. CATEGORIES	I.C.D.A. CODE	TOTAL CASES
Deliveries and Complications	640-689	373
Complications Pregnancy	640-649	237
Abortion	650-652	111
Delivery	660-678	12
Puerperium	680-689	13
Skin Infections	690-716	428
Skin Infections	690-698	-
Other Skin	700-716	-
Diseases of Bones & Movement	720-749	186
Arthritis & Rheumatism	720-727	55
Osteomyelitis	730-738	33
Other Musculoskeletal	740-749	98
Congenital	750-759	11
Diseases of Early Infancy	760-776	16
Diseases of Early Infancy	760-769	8
Other Diseases	770-776	8
Symptoms, Senility and Other	780-795	2582
Injuries & Adverse Effects	800-999	5770
Fractures	800-826	630
Dislocations & Sprains	830-848	671
Head Injury	850-856	532
Chest, Abdomen, Pelvis	860-869	12
Lacerations	870-898	1991
Superficial Injury	910-918	481
Contusion & Crushing	920-929	825
Foreign Body thru Orifice	930-936	157
Burn	940-949	196
CNS Injury	950-959	3
Chemical Injury	960-989	188
Other Adverse	990-999	84
Special Admission and Live & Stillbirth	Y00-Y39	1206
Medical or Special Examination	Y00	129
Skin Tests	Y01	1
Prophylactic Innoculation	Y02	234
Follow-up Examination	Y03	2
Contacts with Infectious Disease	Y04	0
Carrier	Y05	0
Prenatal Care	Y06	496
Postpartum Observation	Y07	1
Healthy Person	Y08	0
Other Person	Y09	0
Medical & Surgical after-care	Y10	343

TABLE VIII

Number of Births and Deaths
Durham-Orange Counties,
North Carolina,
1962

	Total	Durham County	Orange County
TOTAL	3,804	2,678	1,126
Live Births	3,618	2,544	1,074
Infant Deaths	110	84	26
Fetal Deaths	76	50	26

SOURCE: North Carolina State Board of Health

TABLE IX

Number and Cause of Resident Deaths,
Durham-Orange Counties,
North Carolina,
1962

Cause of Death	Deaths		
	Total	Durham County	Orange County
TOTAL	1,274	1,015	259
Heart Disease	466	376	90
Intracranial Vascular Lesions	154	110	44
Nephritis	15	13	2
Other Cardio-Vascular-Renal	38	30	8
Cancer, Leukemia, Hodgkin's	190	148	42
Influenza and Pneumonia	46	35	11
Accident, Motor Vehicle	26	20	6
Accident, House and Farm	24	20	4
Accident, Other	18	17	1
Suicide	9	8	1
Homicide	15	13	2
Diabetes Mellitus	20	18	2
Tuberculosis, all forms	5	5	0
Syphilis	4	4	0
Poliomyelitis	0	0	0
Meningococcal Infections	1	1	0
Measles	1	0	1
Whooping Cough	0	0	0
Diarrhea and Enteritis	3	2	1
Other Reportable Communicable	3	3	0
Prematurity	21	17	4
Maternal Deaths	1	1	0
Residual	214	174	40

SOURCE: North Carolina State Board of Health

TABLE X

Chronic Illness in Homes
Durham & Orange Counties
North Carolina,

1962

Type Illness	Number of Persons		
	Total	Durham County	Orange County
TOTAL	2,245	1,879	366
Malignant Neoplasms	81	63	18
Allergies, etc.	62	54	8
Diabetes	162	139	23
Blood & Blood-forming Disorders	36	22	14
Mental Disorders	853	833	20
Nervous System	151	124	27
Stroke	107	59	48
Circulatory System	191	130	61
Rheumatic Fever	24	22	2
Digestive System	91	73	18
Respiratory System	126	100	26
Genito-Urinary System	96	71	25
Bone Disorders	142	112	30
Other Ill-defined conditions	123	77	46

SOURCE: Durham County Health Department (Miss Shirley Callahan)
Orange County Health Department (Dr. O. David Garvin)

TABLE XI

Medical Caseload From All Bed Sources, By Category of Care Required, Durham & Orange Counties, Daily Census 1962

Category	Medical Caseload	
	Number	Percent
Category I - Hospital Care	426	9
Category II - Physician Care	2,524	53
Categories III & IV - Paramedical & Skilled Lay Care	1,800	38
Total	4,750	100

TABLE XII

Emergency Medical Caseload Expected During a Two Week Period

Category	Expected Caseload	
	Number	Percent
Category I	214	10.7
Category II	907	45.6
Category III & IV	870	43.7
Total	1,991	100

SOURCE: Derived from Emergency Room Data

TABLE XIII

Patient Load (All Sources) Day X Plus Two Weeks

Emergency Room
Case Study

	Category I	Category II	Category III & IV	Total
Developing During Two Week Period	214	907	870	1,991*
Percentage	0.13	0.57	0.54	1.24
In All Hospitals & Beds at Day X	426	2,524	1,800	4,750**
Percentage	.27	1.58	1.12	2.97
TOTAL				6,741
PERCENTAGE				4.21

*Derived from Table XII
**Derived from Table XI

TABLE XIV

Expected Deaths During Two Weeks Without Treatment

	Category I	Category II	Category III & IV	Total
Emergency Room Case Study	90/214	163/907	2/870	255
Percentage	42	18	0.23	0.16
In All Hospital & Beds at Day X	426 x .42	2524 x .18	1800 x .0023	
Number	179	454	4	637

	Total	Percentage
Emergency Room Admissions	255	0.16
In All Hospitals & Beds at Day X	637	0.40
TOTAL	892*	0.56

* The 95% confidence interval around the figure 892 is 759 up to 1,028. This means that the chances are 95 times that of 100 that the true number of deaths in this category would be as low as 759 or as high as 1,028.

TABLE XV

Expected Deaths - Two Week Period

Physician Attending with Medical Supplies

	Category I	Category II	Category III & IV	Total
Emergency Room Case Study	69/214	46/907	0.81/870	115.81
Percentage	32	5.1	.09	0.073
In all Hospitals & Beds at Day X	426 x .32	2524 x .051	1800 x .0009	
Number	136	129	1.62	266.62

	Total	Percentage
Emergency Room Admissions	116	.073
In All Hospitals & Beds at Day X	267	.167
TOTAL	383	0.24

TABLE XVI

Expected Deaths - 2 Week Period

Nurse (or equivalent) with

Medical Supplies

	Category I	Category II	Category III & IV	TOTAL
Emergency Room Case Study	82/214	54/907	1/870	137
Percentage	38.2%	6.0%	0.12%	.086%
In all Hospitals & Beds on Day X	426 x .382	2524 x .06	1800 x .0012	
Number	163	151	2	316
Emergency Room Admission			137	0.086%
In all Beds and Hospitals Day X			316	0.20%
TOTAL			453	0.28%

TABLE XVII

Expected Deaths - 2 Week Period
with Hospitals & Personnel Intact

	Category I	Category II	Category III & IV	Total
Emergency Room Case Study	31	11.5	.35	42.85
Percentage	14.5%	0.13%	0.00%	0.027%
In all Hospitals & Beds on Day X	428 x .145	2518 x .0013	1805 x 0.00	
	62	3	0	65

EXPECTED DEATHS - 2 WEEKS PERIOD - ALL HOSPITAL & BED PATIENTS	
No Treatment	637
With Physician & Equipment	267
With Nurses (or equivalent) & Equipment	316
With Hospitals & Personnel Intact	65

TABLE XVIII

Expected Deaths - 2 Week Period

With Varying Degrees of Austerity

			Hospitals & Personnel Intact (see footnote)	
	Total	Percentage	Total	Percentage
NO TREATMENT	892	0.56%	369	0.23%
Physician in attendance with basic equipment	431	0.27%	230	0.14%
Nurse (or equivalent) in attendance with basic equipment	502	0.31%	251	0.16%

These totals are derived by adding the 2 week totals extrapolated from the Emergency Room Case Study in each condition of austerity (Tables XIV, XV, & XVI) to the expected deaths with hospital and bed patients in undisturbed hospitals (Table XVII).

Appendix A

ESTIMATED DEATHS AMONG HOSPITAL EMERGENCY ROOM CASES AND OTHER* CASES AT VARIOUS LEVELS OF MEDICAL CARE

TABLE A-I

SUMMARY OF HOSPITAL EMERGENCY ROOM AND OTHER* CASES IN EACH CARE CATEGORY, DURHAM-ORANGE COUNTIES, NORTH CAROLINA 1961 - 1962

Care Categories	Total Cases		Estimated Deaths With No Treatment		Estimated Deaths With Treatment With Nurse & Eqpmt.**		Estimated Deaths With Physician and Equipment** in Shelters		Estimated Deaths With Hospitals and Personnel Intact	
	Four-Month Sample	Estimated Two-Week Cases	Four-Month Sample	Estimated Two-Week Deaths	Four-Month Sample	Estimated Two-Week Deaths	Four-Month Sample	Estimated Two-Week Deaths	Four-Month Sample	Estimated Two-Week Deaths
Total (all categories)	17,254	1,991	2,203	255	1,190	137	1,010	116.4	371	42.7
Category I	1,851	214	777	90	707	82	602	69.4	268	30.9
Category II	7,861	907	1,412	163	472	54	401	46.2	100	11.5
Categories III & IV	7,542	870	14	2	9	1	7	0.8	3	.3

* The hospital emergency room cases are supplemented by known birth and infectious disease data in Durham-Orange Counties, North Carolina (13,959 emergency room cases and 3,295 "other" cases).

** See the list of drugs and equipment in Appendix C.

TABLE A-II

Hospital Emergency Room and Other* Cases in Each Disease
And Injury Category, Durham-Orange Counties, North Carolina
1961 - 1962

Disease and Injury Categories	Total Cases		Estimated Deaths With No Treatment		Estimated Deaths With Treatment by Nurse and Equipment**		Estimated Deaths With Physician and Equipment** In Shelters		Estimated Deaths With Hospitals and Personnel Intact
	Four-Month Sample	Estimated Two-Week Cases	***Case-Fatality (%)	Number	***Case-Fatality (%)	Number	***Case-Fatality (%)	Number	Number
Category I	1851	214		777		707		602	268
Trauma									
Fractures									
Skull	54	6.23		54		54		54	27
Vertebra without Cord	9	1.04		5		5		5	2
Vertebra with Cord	2	0.23		2		2		2	1
Pelvis	8	0.92		6		6		6	0
Femur	55	6.46		33		20		11	5
Dislocation of Hip	3	0.35		2		2		2	0
Head Injury									
Concussion	48	5.54	25%	12		12		12	6
Contusion	1	0.12		1		1		1	0
Subarach.;Sub.& Extra Dural	3	0.35		3		3		3	2
Other, Intracranial Hem.	1	0.12		1		1		1	1
Internal Injury									
Heart & Lung	3	0.35		3		3		3	1
G. I. Tract	1	0.12		1		1		1	0
Spleen	1	0.12		1		1		1	0
Kidney	1	0.12		1		1		1	0
Pelvis Organs	2	0.23		2		2		2	1
Chest & Abdomen	4	0.46		4		4		4	2

* The hospital emergency room cases are supplemented by known birth and infectious disease data in Durham-Orange Counties, North Carolina (13,959 emergency room cases and 3,295 "other" cases).

** See the list of drugs and equipment in Appendix C.

*** Estimated percent of deaths among cases in each disease and injury category at the stated level of care.

Disease and Injury Categories	Total Cases		Estimated Deaths With No Treatment		Estimated Deaths With Treatment by Nurse and Equipment**		Estimated Deaths With Physician and Equipment** In Shelters		Estimated Deaths With Hospitals and Personnel Intact
	Four-Month Sample	Estimated Two-Week Cases	***Case-Fatality (%)	Number	***Case-Fatality (%)	Number	***Case-Fatality (%)	Number	Number
Laceration & Open Wound									
Eye & Orbit	44	5.07	25%	11		8		5	4
Enucleation	1	0.12		1		1		1	0
Foreign Body through Orifice									
Eye & Adexna	83	9.58	10%	9		9		9	2
Pharynx & Larynx	13	1.50	50%	7		7		7	3
Bronchus & Lung	1	0.12		1		1		1	0
Burns									
Head & Face(>15%)	109	12.58	50%	60		45		30	10
Nerves & Cord									
Cord (only)	1	0.12		1		1		1	1
Chemical - Adverse									
Cyanides, CO, Fumes, etc.	27	3.12	50%	14		14		14	7
Other Adverse									
Traumatic Shock	1	0.12		1		1		1	0
Surgical Complications	3	0.35	33%	1		1		1	0
Serum Jaundice, etc.	3	0.35	66%	2		2		2	1
Infection									
Meningococcus	2	0.23		2		2		1	0
Rocky Mountain Spotted	2	0.23		2		2		1	0
Rheumatic Fever	5	0.58	60%	3		3		0	0
Pneumonia	153	17.65	30%	50	10%	35	10%	15	8
Peritonsillar Abscess	6	0.69	66%	4		4		2	1
Lung Abscess	2	0.23		1		1		1	0
Paralytic Poliomyelitis	1	0.12		1		1		1	0
Nephritis	3	0.35	66%	2		2		2	1
Septic Abortion	3	0.35		3		3		2	1
Osteomyelitis	8	0.92	75%	6		6		4	2
Umbilical Infection	4	0.46	75%	3		3		1	1

Disease and Injury Categories	Total Cases		Estimated Deaths With No Treatment		Estimated Deaths With Treatment by Nurse and Equipment**		Estimated Deaths With Physician and Equipment** In Shelters		Estimated Deaths With Hospitals and Personnel Intact
	Four-Month Sample	Estimated Two-Week Cases	***Case-Fatality (%)	Number	***Case-Fatality (%)	Number	***Case-Fatality (%)	Number	Number
Congenital									
Other Diseases of Infancy									
Birth Injury	1	0.12		1		1		1	1
Asphyxia	1	0.12		1		1		1	1
Diarrhea	4	0.46		4		4		4	2
Erythroblastosis	1	0.12		1		1		1	0
Hemorrhagic Disease	2	0.23		2		2		2	1
Nutritional Maladjustment	4	0.46	75%	3		3		3	1
Metabolic									
Asthma	252	29.10	25%	60	10%	45	10%	25	10
Thyrotoxicosis	2	0.23		1		1		1	0
Nervous System									
Vascular Intracranial Hemorrhage & Thrombosis	79	9.12	75%	60		60		60	40
Inflammatory Meningitis	10	1.15	75%	8		8		8	4
Other CNS: Cerebral & Spinal Paralysis	4	0.46		4		4		4	2
Eye									
Abscess & Cellulitis	19	2.19	50%	10	10%	8	10%	2	2
Corneal Ulcer	2	0.23		0		0		0	0
Retinal Detachment	1	0.12		0		0		0	0
Glaucoma	1	0.12		0		0		0	0
Ear									
Mastoiditis	2	0.23	50%	1		1		1	0
Circulatory									
Coronary & Heart	79	9.12	75%	60		56		48	40
Embolus (Limb)	1	0.12		1		1		1	0
Gangrene	1	0.12		1		1		1	0
Pulmonary Embolus	6	0.69		6		6		6	6
Other Embolus & Thrombosis	5	0.58		3		3		3	1
Digestive									
Disease of Esophagus	7	0.81	25%	2		2		2	1
Stomach & Duodenal Ulcer	64	7.39	25%	16		16		16	6
Appendicitis	101	11.65	10%	10		8	5%	5	2
Hernia & Obstruction	9	1.04		9		9		9	2

Disease and Injury Categories	Total Cases		Estimated Deaths With No Treatment		Estimated Deaths With Treatment by Nurse and Equipment**		Estimated Deaths With Physician and Equipment** in Shelters		Estimated Deaths With Hospitals and Personnel Intact
	Four-Month Sample	Estimated Two-Week Cases	***Case-Fatality (%)	Number	***Case-Fatality (%)	Number	***Case-Fatality (%)	Number	Number
Intestinal Obstruction	26	3.00		26		26		26	14
Perianal Abscess	11	1.27	50%	6		5	10%	1	1
Peritonitis	2	0.23		2		2		2	1
Suppurative Hepatitis	3	0.35		3		3		3	2
Cholecystitis & Cholelithiasis	23	2.66	10%	2		2		2	1
Genito-Urinary									
Kidney Infection	41	4.73	10%	4		4	5%	2	1
Kidney & Ureter-Stone	79	9.12	5%	4		4		4	1
Urethral Stricture	3	0.35		1		1		1	0
BPH	4	0.46	50%	2		2	25%	1	0
Deliveries & Complications									
Complications, Pregnancy									
Toxemia	9	1.04	50%	5		5	25%	3	1
Hemorrhage before Labor	25	2.88	75%	18		18		18	3
Ectopic	5	0.58		5		5		5	3
Threatened Abortion, Premature Rupture	67	7.74	5%	3		3		3	1
Delivery									
Retained placenta	2	0.23		2		2		2	0
Hemorrhage	2	0.23		2		2		2	1
Symptoms Referable to CNS									
Coma, Delirium, Convulsions	119	13.74	50%	60		60		60	30
Symptoms Referable to CVS									
Pain, Pallor, Syncope, Palpitation, Tachy, etc.	99	11.40	50%	50		50		50	25
Senility & Ill-defined									
Uremia	2	0.23		2		2		2	2

Disease and Injury Categories	Total Cases		Estimated Deaths With No Treatment		Estimated Deaths With Treatment by Nurse and Equipment**		Estimated Deaths With Physician and Equipment** in Shelters		Estimated Deaths With Hospitals and Personnel Intact
	Four-Month Sample	Estimated Two-Week Cases	***Case-Fatality (%)	Number	***Case-Fatality (%)	Number	***Case-Fatality (%)	Number	Number
Category II	7861	907		1412		472		401	100
Trauma									
Fractures									
Ribs	39	4.50	10%	4		3	5%	2	0
Clavicle	12	1.38		0		0		0	0
Coccyx	23	2.66		0		0		0	0
Scapula	5	0.58		1		1		1	0
Humerus	41	4.73	20%	8		6	5%	2	1
Radius and/or Ulna	111	12.80	10%	11		9	5%	6	1
Carpal Bones	27	3.12							
Metacarpel	25	2.86							
Phalanges	54	6.23		0		0		0	0
Hand Bones (Multiple)	2	0.23							
Patella	3	0.35							
Tibia and/or Fibula	60	6.92	25%	15		12	10%	6	1
Ankle	37	4.27	20%	7		6	10%	4	1
Tarsal/Metatarsal	34	3.92	10%	3		3	5%	2	1
Phalanges (Foot)	29	3.35		0		0			0
Dislocations									
Jaw	4	0.46		0		0		0	0
Shoulder	17	1.96		0		0		0	0
Elbow	8	0.92		0		0		0	0
Wrist	2	0.23		0		0		0	0
Finger	3	0.35		0		0		0	0
Knee	34	3.92		0		0		0	0
Foot	6	0.69		0		0		0	0
Head Injury									
Open Wound of Scalp	273	31.50	5%	15		10	2%	5	3
Contusion-Hematoma of Scalp	61	7.04	5%	3		3		3	0
Head Injury-Unspec.	145	16.73	25%	35		35		35	15
Laceration & Open Wound									
Ear	24	2.77							
Neck	6	0.69							
Chest (Wall)	26	3.00							
Back	11	1.27							
Buttock	6	0.69							

Disease and Injury Categories	Total Cases		Estimated Deaths With No Treatment		Estimated Deaths With Treatment by Nurse and Equipment**		Estimated Deaths With Physician and Equipment** in Shelters		Estimated Deaths With Hospitals and Personnel Intact
	Four-Month Sample	Estimated Two-Week Cases	***Case-Fatality (%)	Number	***Case-Fatality (%)	Number	***Case-Fatality (%)	Number	Number
Genital (External)	9	1.04							
Face, Neck, Trunk	49	5.66							
Shoulder & Upper Arm	24	2.77							
Elbow, Forearm, Wrist	248	28.60	10%	130		90	5%	65	10
Finger(s)	385	44.50							
Upper Limb	7	0.81							
Thumb (Amputation)	1	0.12							
Finger(s) (Amputation)	18	2.08							
Hip & Thigh	23	2.66							
Knee, Leg, Foot, Toes	430	49.60							
Lower Limb, Multiple	24	2.77							
Foreign Body Through Orifice									
Ear	11	1.27		0		0		0	0
Nose	9	1.04							
Digestive System	40	4.62							
Burn									
Upper Limb	43	4.96	10%	4		3		2	0
Wrist & Hand	44	5.08	10%	4		3		2	0
Nerves & Cord									
Forearm	1	0.12		0		0		0	0
Wrist/Hand	1	0.12		0		0		0	0
Chemical - Adverse									
Venom, Alcohol, Solvents	60	6.92	25%	15		15		15	3
Metals, non-Medical	2	0.23		0		0		0	0
Antibiotics	8	0.92		1		1		1	1
Anti-infective (Sulphonemides, As, Ag., etc.)	3	0.35		0		0		0	0
Hormones	4	0.46		0		0		0	0
Enzymes, Vitamins, Blood, Immuno.	5	0.58		0		0		0	0
Analgesics, anti-pyretics, Sedatives	48	5.54		0		0		0	0
CNS Stimulants, Psycho-therapeutic	5	0.58		0		0		0	0
G.I. Drugs & Other	26	3.00		0		0		0	0

Disease and Injury Categories	Total Cases		Estimated Deaths With No Treatment		Estimated Deaths With Treatment by Nurse and Equipment**		Estimated Deaths With Physician and Equipment** in Shelters		Estimated Deaths With Hospitals and Personnel Intact
	Four-Month Sample	Estimated Two-Week Cases	***Case-Fatality (%)	Number	***Case-Fatality (%)	Number	***Case-Fatality (%)	Number	Number
Other Adverse									
Wound Infection, etc.	67	7.74	50%	35		21	10%	7	5
Infection									
Tuberculosis	18	2.00		1		1		1	0
Syphilis	34	4.00		1		1		1	0
Gonorrhea	450	52.00		1		1		1	0
Malaria	1	0.12		0		0		0	0
Bacillary Dysentery	1	0.12		0		0		0	0
Food Poisoning	4	0.46	25%	1		1		1	1
Scarlet Fever	4	0.46	25%	1		1		1	0
Streptococcus Throat	18	2.08	50%	1		1		1	0
Septicemia	4	0.46	50%	2		2		2	1
Diptheria	1	0.12		1		1		1	0
Whooping Cough	5	0.58	20%	1		1		1	0
Vaccinia	8	0.92		0		0		0	0
Measles	120	14.00	20%	30		25	10%	15	5
Rubella	1	0.12		0		0		0	0
Chicken Pox	9	1.04		0		0		0	0
Herpes Zoster	7	0.81		0		0		0	0
Mumps	20	2.31		0		0		0	0
Infectious Hepatitis	12	1.38	10%	2		2		2	1
Glandular Fever	3	0.35		0		0		0	0
Other Virus	18	2.08	10%	5		5		5	2
Other Infective & Parasitic	25	2.88							
Encephalitis	1	0.12		1		1		1	1
Salmonellosis	9	1.04	10%	1		1		1	0
Shigellosis	10	1.15	10%	1		1		1	0
Metabolic									
Diabetes Mellitis	59	6.80	10%	6		4		3	1
Other (Pancreas, Parathyroid, Adrenal)	6	0.69		0		0		0	0
Blood & Blood-forming Organs									
Anemia, Familila, Acute Hemolytic, etc.	5	0.58		0		0		0	0
Hemophilia	4	0.46		0		0		0	0
Purpura	2	0.23	50%	1		1		1	1
Spleen Diseases	2	0.23		0		0		0	0

Disease and Injury Categories	Total Cases		Estimated Deaths With No Treatment		Estimated Deaths With Treatment by Nurse and Equipment**		Estimated Deaths With Physician and Equipment** In Shelters		Estimated Deaths With Hospitals and Personnel Intact
	Four-Month Sample	Estimated Two-Week Cases	***Case-Fatality (%)	Number	***Case-Fatality (%)	Number	***Case-Fatality (%)	Number	Number
Mental									
Chronic Brain-Convulsive	1	0.12		0		0		0	0
Phychotic-Schizophrenia	9	1.04		0		0		0	0
Nervous System									
Inflammatory Demyelinating	1	0.12		0		0		0	0
Ear									
Otitis Media	123	14.20	10%	13		10	5%	7	2
Circulatory									
Hypertensive CVD	59	6.81	5%	3		3		3	0
Phlebitis	13	1.50		0					
Respiratory									
Acute Sinusitis	8	0.92							
Acute Pharyngitis	251	29.00	5%	20		11	2%	8	0
Acute Tonsillitis	183	21.10							
Acute Laryngiti & Tracheitis	14	1.62							
Influenza	57	6.58	10%	5		4	5%	3	1
Pleurisy	16	1.85	25%	4		3	10%	2	1
Pneumothorax	2	C.23		0					
Pulmonary Congestion	4	0.46	25%	1		1		1	1
Digestion									
Tooth Abscess	16	1.85	10%	1		1		1	0
Pancreatic Diseases	9	1.04	10%	1		1		1	1
Genito-Urinary									
Bladder Stone	1	0.12		0		0		0	0
Cystitis	27	3.12		0		0		0	0
Urethritis	2	0.23		0		0		0	0
Urethral-Other	43	4.96		0		0		0	0
Prostatitis	9	1.04		0		0		0	0
Orchitis & Epididymites	15	1.73	10%	2		2		2	0
Phimosis	4	0.46		0		0		0	0
Other Malegenital	13	1.50		0		0		0	0
Breast Abscess	19	2.19		0		0		0	0
P.I.D. & Other	25	2.88	10%	3		3	5%	2	0
Uterine Infection	55	6.47	25%	15		10	10%	5	3

Disease and Injury Categories	Total Cases		Estimated Deaths With No Treatment		Estimated Deaths With Treatment by Nurse and Equipment**		Estimated Deaths With Physician and Equipment** In Shelters		Estimated Deaths With Hospitals and Personnel Intact
	Four-Month Sample	Estimated Two-Week Cases	***Case-Fatality (%)	Number	***Case-Fatality (%)	Number	***Case-Fatality (%)	Number	Number
Deliveries & Complications									
Deliveries	1268	146.30	15%	190	3%	40	1%	12	5
GU Infection	2	0.23		0		0		0	0
Prolonged Labor	5	0.58	20%	1		1		1	1
Live Births	1206	140.00	60%	724	5%	60	10%	120	24
Skin & Cellular Tissues									
Boil & Carbuncle	39	4.50							
Cellulitis, Finger/Toe	85	9.82							
Cellulitis, Finger	150	17.30	20%	60		30	5%	15	5
Cellulitis, Finger with Abscess	6	0.69							
Acute Lymphangitis	9	1.04							
Symptoms, Senility & Ill-defined Respiratory (Dyspnea, Cough, Hemoptysis, Epixtaxis, Pain, etc.)		46.00	5%			20		20	5
Special Conditions									
Medical or Special Exam.		14.90				0		0	0
Category III & IV	7542	870		14		9		7	3
Trauma									
Sprains & Strains									
Shoulder & Upper Arm	18	2.08		0		0		0	0
Elbow & Forearm	17	1.96		0		0		0	0
Wrist & Hand	78	8.90		0		0		0	0
Hip & Thigh	15	1.73		0		0		0	0
Knee & Leg	60	6.92		0		0		0	0
Ankle & Foot	247	28.50		0		0		0	0
Sacroillac	34	3.92		0		0		0	0
Back (Unspecified)	80	9.24		0		0		0	0
Other (Ill-defined)	45	5.20		0		0		0	0

Disease and Injury Categories	Total Cases		Estimated Deaths With No Treatment		Estimated Deaths With Treatment by Nurse and Equipment**		Estimated Deaths With Physician and Equipment** In Shelters		Estimated Deaths With Hospitals and Personnel Intact
	Four-Month Sample	Estimated Two-Week Cases	***Case-Fatality (%)	Number	***Case-Fatality (%)	Number	***Case-Fatality (%)	Number	Number
Superficial Injury									
Face, Neck, Scalp	76	8.77		0		0		0	0
Trunk	9	1.04		0		0		0	0
Shoulder & Upper Arm	8	0.92		0		0		0	0
Elbow, Forearm, Wrist	29	3.35		0		0		0	0
Hand	26	3.00		0		0		0	0
Fingers	34	3.92		0		0		0	0
Hip, Thigh, Leg, Ankle	77	8.88		0		0		0	0
Foot, & Toes	32	3.69		0		0		0	0
Multiple & Unspecified Sites	190	21.90		0		0		0	0
Contusions & Crushing with Intact Skin									
Face & Neck	89	10.25		0		0		0	0
Eye & Orbit	48	5.54		0		0		0	0
Trunk	96	11.10		0		0		0	0
Shoulder & Upper Arm	49	5.75		0		0		0	0
Elbow, Forearm, Wrist	82	9.46		0		0		0	0
Hand(s)	63	7.27		0		0		0	0
Finger(s)	124	14.30		0		0		0	0
Hip, Thigh, Leg, Ankle	144	16.60		0		0		0	0
Foot & Toes	83	9.58		0		0		0	0
Multiple & Unspecified	47	5.42		0		0		0	0
Tumors									
Malignant	43	4.96	5%	2		1	2%	1	1
Benign	33	3.81		0		0		0	0
Other	9	1.04		0		0		0	0
Congenital									
Hydrocephalus	1	0.12							
Malformation, Circulatory	6	0.69	10%	1		1		1	1
Malformation, Digestive	3	0.35							
Malformation, Bones/Joints	1	0.12							
Metabolic									
Allergic									
Hay Fever	6	0.69		0		0		0	0
Angioneurotic Oedema	1	0.12		0		0		0	0
Urticaria	21	2.42		0		0		0	0
Other (Conjunctivitis,etc.)	57	6.58		0		0		0	0

Disease and Injury Categories	Total Cases		Estimated Deaths With No Treatment		Estimated Deaths With Treatment by Nurse and Equipment**		Estimated Deaths With Physician and Equipment** In Shelters		Estimated Deaths With Hospitals and Personnel Intact
	Four-Month Sample	Estimated Two-Week Cases	***Case-Fatality (%)	Number	***Case-Fatality (%)	Number	***Case-Fatality (%)	Number	Number
Thyroid									
Simple Goiter	3	0.35		0		0		0	0
Myxoedema & Cretinism	1	0.12		0		0		0	0
Other	1	0.12		0		0		0	0
Avitaminosis & Other									
Pellegra	1	0.12		0		0		0	0
Other	1	0.12		0		0		0	0
Obesity	2	0.23		0		0		0	0
Gout	4	0.46		0		0		0	0
Other	1	0.12		0		0		0	0
Blood & Blood-Forming Organs									
Iron Deficiency Anemia	3	0.35		0		0		0	0
Unspecified Anemia	11	1.27		0		0		0	0
Mental									
Chronic Brain									
Senile	1	0.12		0		0		0	0
Other (Multiple Sclerosis, Pick's, etc.)	2	0.23		0		0		0	0
Psychoneurotic (Anxiety, Conversion, Phobie, Depressive, Obsessive)	128	14.80		0		0		0	0
Psychophysiologic (Emot. Blind, Deafness, Hyperventilation, etc.)	18	2.08		0		0		0	0
Nervous System									
Other CNS									
Paralysis Agitans	1	0.12		0		0		0	0
Cerebro-Spastic	1	0.12		0		0		0	0
Nerves & Ganglia (Facial Paral., tic dol., neuritis, etc.)	20	2.31		0		0		0	0
Eye									
Conjunctivitis	28	3.23		0		0		0	0
Blepharitis	2	0.23		0		0		0	0
Other	13	1.50		0		0		0	0

Disease and Injury Categories	Total Cases		Estimated Deaths With No Treatment		Estimated Deaths With Treatment by Nurse and Equipment**		Estimated Deaths With Physician and Equipment** In Shelters		Estimated Deaths With Hospitals and Personnel Intact
	Four-Month Sample	Estimated Two-Week Cases	***Case-Fatality (%)	Number	***Case-Fatality (%)	Number	***Case-Fatality (%)	Number	Number
Ear									
Otitis Externa	13	1.50		0		0		0	0
Other (Otoscl,Deaf.,Labyrinth)	27	3.12		0		0		0	0
Circulatory									
Chronic Rheumatic Heart	1	0.12		0		0		0	0
Functional	15	1.73		0		0		0	0
Other & Unspec.	51	5.89		0		0		0	0
Generalized Arteriosclerosis	7	0.81		0		0		0	0
PVD	1	0.12		0		0		0	0
Varicose Veins	8	0.92		0		0		0	0
Piles	33	3.81		0		0		0	0
Varices, Other	3	0.35		0		0		0	0
Lymphatic	10	1.15		0		0		0	0
Respiratory									
Common Cold	722	83.40		0		0		0	0
Bronchitis, Acute & Chronic	116	13.40		1		0		0	0
Hypertrophy of T & A	5	0.58		0		0		0	0
Chripharyngitis & Nasoph.	3	0.35		0		0		0	0
Chr. Sinusitis	12	1.38		0		0		0	0
Bronchiectasis	4	0.46		0		0		0	0
Other, Lungs & Pleura	9	1.04		0		0		0	0
Digestive									
Caries	6	0.69		0		0		0	0
Other, Inflam. Teeth	7	0.81		0		0		0	0
Occlusive Disorder	1	0.12		0		0		0	0
Toothache	45	5.20		0		0		0	0
Other	7	0.81		0		0		0	0
Stomatitis	25	2.88		0		0		0	0
Gastritis & Duodenitis	63	7.27		0		0		0	0
Disorders of Stomach Funct.	26	3.00		0		0		0	0
Hernia without Obstruction	26	3.00		0		0		0	0
Gastroenteritis & Collitis	188	21.70		0		0		0	0
Ulcerative Colitis	15	1.73		0		0		0	0
Functional	30	3.46		0		0		0	0
Other Intestine & Peritoneum	60	6.92		0		0		0	0
Cirrhosis	10	1.15		0		0		0	0
Other Biliary	20	2.31		0		0		0	0

Disease and Injury Categories	Total Cases		Estimated Deaths With No Treatment		Estimated Deaths With Treatment by Nurse and Equipment**		Estimated Deaths With Physician and Equipment** In Shelters		Estimated Deaths With Hospitals and Personnel Intact
	Four-Month Sample	Estimated Two-Week Cases	***Case-Fatality (%)	Number	***Case-Fatality (%)	Number	***Case-Fatality (%)	Number	Number
Genito-Urinary									
Hydrocele	1	0.12		0		0		0	0
Other, Ovary & Tube	20	2.31		0		0		0	0
Malposition Uterus	3	0.35		0		0		0	0
Menses, Irreg.	68	7.85		0		0		0	0
Menopause	2	0.23		0		0		0	0
Other, Female (Leuko., Lac. Cervix, etc.)	109	12.58		0		0		0	0
Deliveries & Complications									
Abortion	108	12.46	10%	10		7	5%	5	1
Puerperium (URL, phlebitis, Anemia, etc.)	13	1.50		0		0		0	0
Diseases Skin & Cellular Tissue									
Impetigo	22	2.54		0		0		0	0
Other, Skin & Subcut.	10	1.15		0		0		0	0
Dermatitis	62	7.15		0		0		0	0
Psoriasis	1	0.12		0		0		0	0
Pruritis	2	0.23		0		0		0	0
Other	2	0.23		0		0		0	0
Diseases of Nail	10	1.15		0		0		0	0
Diseases of Sweat Glands	3	0.35		0		0		0	0
Other, Skin	3	0.35		0		0		0	0
Diseases Bones & Joints & Organs of Movement									
Rheumatoid	3	0.35		0		0		0	0
Osteoarthritis	4	0.46		0		0		0	0
Arthritis, Unspec.	19	2.19		0		0		0	0
Muscular Rheumatism	29	3.35		0		0		0	0
Osteochronditis	2	0.23		0		0		0	0
Bone, Other	3	0.35		0		0		0	0
Int. Derangement Knee	4	0.46		0		0		0	0
Ruptured Disc	11	1.27		0		0		0	0
Other, Joint	4	0.46		0		0		0	0
Bunion	1	0.12		0		0		0	0
Bursitis	54	6.23		0		0		0	0
Foreign Body, Residual	17	1.96		0		0		0	0
Myositis	7	0.81		0		0		0	0

Disease and Injury Categories	Total Cases		Estimated Deaths With No Treatment		Estimated Deaths With Treatment by Nurse and Equipment**		Estimated Deaths With Physician and Equipment** In Shelters		Estimated Deaths With Hospitals and Personnel Intact
	Four-Month Sample	Estimated Two-Week Cases	***Case-Fatality (%)	Number	***Case-Fatality (%)	Number	***Case-Fatality (%)	Number	Number
Other Muscle	1	0.12		0		0		0	0
Spine Curvature	1	0.12		0		0		0	0
Clubfoot	15	1.73		0		0		0	0
Other Deformities	2	0.23		0		0		0	0
Symptoms, Senility. & Ill-defined Conditions									
G.I. Tract (Anerexia, Heart-burn, Pylorospasm, etc.)	206	23.80		0		0		0	0
Abdomen & Lower G.I. (Jaundice, Diarrhea, Melena, Flatulence)	520	60.00		0		0		0	0
G.U. Symptoms	100	11.54		0		0		0	0
Low Back & Limbs	250	28.80		0		0		0	0
Other, General (Rash, Wt. Loss, P.U.O., Tetany, Dehydration, Acidosis, Alkalosis, Sweating)	392	45.25		0		0		0	0
Abnormal Urinary	27	3.12		0		0		0	0
Senility & Ill-defined	5	0.58		0		0		0	0
Nervous & Debilitated	75	8.66		0		0		0	0
Headache	143	16.50		0		0		0	0
Observation Without Need for Further Care	110	12.70		0		0		0	0
Ill-defined & Unknown Causes for Sickness or Death	131	15.10		0		0		0	0
Special Condictions & Exam.									
Skin Test	1	0.12		0		0		0	0
Prophy. Inoculation	234	27.00		0		0		0	0
Prenatal Care	496	57.20		0		0		0	0
Postpartum Observation	1	0.12		0		0		0	0
Med. & Surg. After-Care	343	39.60		0		0		0	0

Disease and Injury Categories	Total Cases	
	Four-Month Sample	Estimated Two-Week Cases
Category V (Total)	1302	
Isolation		
Tuberculosis	67	23.10
Syphilis	34	4.00
Gonorrhea	450	52.00
Diptheria	1	0.12
Whooping Cough	1	0.12
Measles	120	14.00
Mumps	20	2.31
Infectious Hepatitis	12	1.38
Poliomyelitis	1	0.12
Restrain		
Alcoholic	63	7.27
Schizophrenia	6	0.69
Sociopathic	42	4.85
Sequester		
Deaths	425	49.00

Appendix B

NORTH CAROLINA MEMORIAL HOSPITAL: ONE DAY CENSUS

(30 May 1963)

CATEGORY I

Trauma	
Fractures	
Skull	1
Vertebra without cord	2
Vertebra with cord	2
Femur	7
Dislocation of hip	1
Mandible	1
Head injury	
Concussion	1
Contusion	4
Gunshot wound - brain	1
Laceration and open wound	
Foot	1
Burns	
Head & face or more than 15%	10
Nerves & cord	
Cord (only)	3
Infection	
H. Influenza	1
Rheumatic fever	2
Pneumonia	7
Lung abscess	1
Paralytic poliomyelitis	1
Nephritis	3
Osteomyelitis	2
Subacute bacterial endocarditis	1
Congenital	
Other diseases of infancy	
Nutritional maladjustment	1
Metabolic	
Asthma	3

Appendix B

Nervous System	
Vascular	
Intracranial hemorrhage & thrombosis	3
Other CNS	
Cerebral & spinal paralysis	2
Meningomyelocoele	2
Eye	
Retinal detachment	1
Glaucoma	2
Ear	
Mastoiditis	2
Circulatory	
Coronary & heart	2
Embolus (limb)	2
Gangrene	4
Other embolus & thrombosis	1
Aortic insufficiency	1
Mitral stenosis	2
Coarctation	1
Congestive heart failure	3
Congenital heart disease	3
Aneurysm	1
Digestive	
Disease of oesophagus	1
Stomach & duodenal ulcer	5
Cirrhosis with ascites	1
Intestinal obstruction	3
Peritonitis	1
Cholecystitis & cholelithiasis	4
G. I. bleeders	9
Ulcerative colitis	3
Genito-urinary	
Kidney infection	1
Kidney & ureteral stone	3
Benign prostatic hypertrophy	2

Appendix B

Deliveries & complications of pregnancy	
Complications of pregnancy	
Toxemia	2
Hemorrhage before labor	3
Incomplete abortion	3
Premature	10
Delivery	
Birth injury	2
Symptoms referable to CNS	
Coma, delirium & convulsions, etc.	1
Senility & ill-defined	
Uremia	3
Total	145

Appendix B

NORTH CAROLINA MEMORIAL HOSPITAL: ONE DAY CENSUS

(30 May 1963)

CATEGORY II

Trauma	
Fractures	
Humerus	2
Carpal bones	1
Tibia and/or fibula	1
Infection	
Tuberculosis	52
Chicken pox	1
Toxoplasmosis	1
Metabolic	
Diabetes mellitus	9
Blood & blood-forming organs	
Anemia, familial, acute hemolytic, etc.	1
Hemophilia	1
Mental	
Psychotic	4
Nervous system	
Epilepsy	2
Circulatory	
Hypertensive CVD	12
Respiratory	
Acute tonsillitis	1
Genito-urinary	
Cystitis	2
Urethritis	1
Deliveries & Complications of Pregnancy	
Deliveries	18
Total	109

Appendix B

NORTH CAROLINA MEMORIAL HOSPITAL: ONE DAY CENSUS

(30 May 1963)

CATEGORIES III & IV

Trauma	
Superficial injury	
Hand	1
Fingers	1
Tumors	
Malignant	36
Benign	2
Metabolic	
Thyroid	
Myxoedema & cretinism	1
Blood-forming organs	
Unspecified anemia	1
Mental	
Psychoneurotic (anxiety, conversion, phobia, obsessive, depressive, etc.)	25
Nervous System	
Post-traumatic encephalopathy	1
Other CNS	
Paralysis agitans	1
Horner's	1
Meniere's	1
Nerves & ganglia (facial paralysis, tic douloureux, neuritis, etc.)	2
Eye	
Squint	1
Circulatory	
Peripheral vascular disease	2
Lymphatic	1
Respiratory	
Emphysema	1
Digestive	
Gastritis & duodenitis	1
Hernia without obstruction	6
Gastro-enteritis & colitis	1

Appendix B

Genito-urinary	
Other, ovary & tube	1
Malposition of uterus	3
Cervicitis	1
Deliveries & Complications of Pregnancy	
Newborn	19
Diseases of Skin & Cellular Tissues	
Nevus	1
Dermatitis	2
Other (ulcer)	1
Scar	1
Diseases of Bones, Joints & Organs of Movement	
Rheumatoid arthritis	4
Arthritis, unspecified	1
Bone, other	1
Myositis	1
Symptoms, senility & ill-defined conditions	
Abdomen & lower G.I. (anorexia, heartburn, jaundice, diarrhea, melena, gas)	1
Low back & limbs	4
Other, general (rash, weight loss, P.U.O., tetany, dehydration, acidosis, alkalosis, sweating)	2
Observation without need for further care	2
Special conditions & examinations with sickness	1
Medical & surgical after care	1
Total	133

Appendix B

NORTH CAROLINA MEMORIAL HOSPITAL: ONE DAY CENSUS

(30 May 1963)

CATEGORY V

Isolation	
Tuberculosis	52*
Staphylococcal pyoderma	1
Restrain	
Sociopathic	1
Sequester	
Deaths	1+**
Total	3+

*Already counted in Category II
**Based on: 372 hospital deaths in 1962
+ 6 coroner's cases from outside 1962

Total 378 deaths moving through morgue in 1962

Appendix C

MEDICAL EQUIPMENT

Drugs

- Gantrisin & Sulfadiazine
- Penicillin, Tetracycline, Chloroamphenicol
- Insulin
- Morphine
- Darvon
- Aspirin
- Barbituate
- Ataractic drug
- Multi-Vitamin
- Benzadrine
- Whiskey or Rum 100 - 150 proof
- Digitoxin
- Adrenalin
- Bicarbonate of Soda
- Magnesium Sulfate
- Phospholine Iodide
- Opthalmic Ointment
- Salt Tablets

Supplies

- Instruments
- Dressing
- Splints
- Aqueous benalkonium
- Catheters
- Asepto syringe
- ½% Xylocaine
- Ether
- Chloroform
- Alcohol 70%
- Infant Food
- Embalming equipment
- DDT

The Research Triangle Institute, Durham, N. C.
OCD Project 1341A Final Report R-OU-107

<u>Shelter Medical Support System Study</u>, Part I by W. T. Herzog; Part II by W. L. Wells, M.D. and W. J. Cromartie, M.D.; R-OU-107, 31 August 1963, Unclassified. 137 pp, 25 references.

Part I studies various policies of allocating medical resources (manpower and material) in an area network of public fallout shelters during a post-nuclear emergency period of two weeks. It is concluded that a policy of assigning medical resources to large shelters is superior to concentrating them in hospitals or treatment centers. The near optimal strategy requires dispersal of physicians in high

(over)

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(over)

PF shelters, because of their potential value in the post-shelter period. In fallout only environments, medical support of the population would place minimal demands on the transportation, shelter management, and warning systems. Demands on the communications system are likely to be excessive. Recommendations of additional research for medical planning are included.

Part II includes background data essential for the measures of effectiveness used in Part I. Treatment requirements and expected fatality (at various levels of medical care) of the hospital emergency room caseload in Durham-Orange Counties, N. C. are described.

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